

# CHEMICAL & METALLURGICAL ENGINEERING

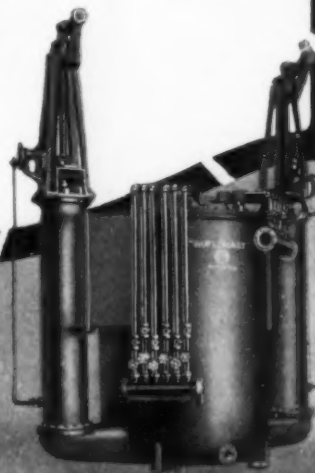


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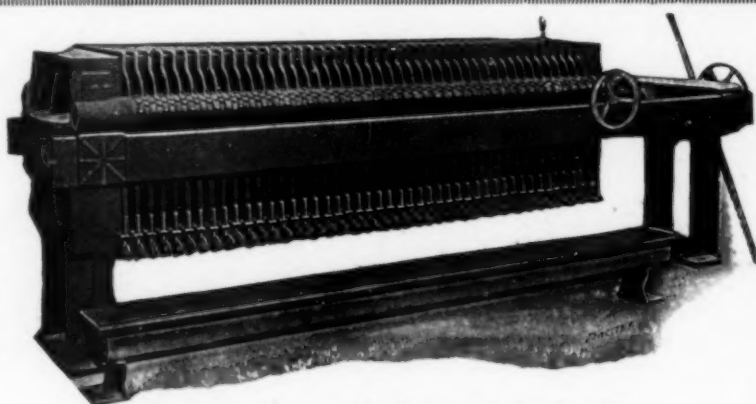
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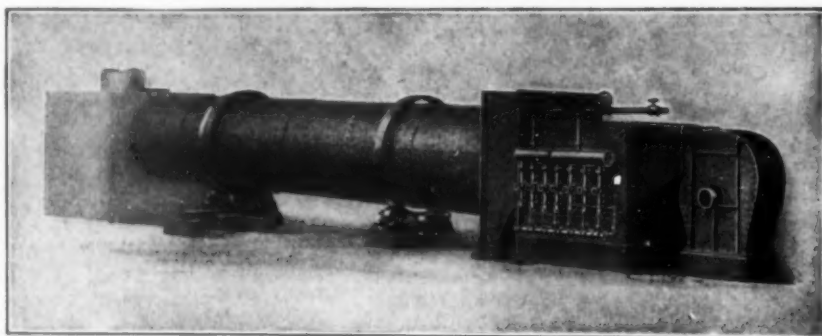
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# CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of  
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Number 3

## New Chemical Laboratory For Cornell University

**A**N UNNAMED donor has agreed to build a new chemical laboratory for Cornell University which shall be adequate to its needs. The University has been sorely crippled by the loss by fire of the major portion of its old laboratory, and unless present plans miscarry the new structure, which will cost over \$1,000,000, will be ready for occupancy by the spring of 1920. This proper housing of the learned and able Cornell staff, and its body of students of chemistry, is a matter for congratulation on behalf of all who have the welfare of chemistry in America at heart. Speculation is rife among the alumni as to the benefactor's name, and while President SCHURMAN is firm in his silence in this respect, it is believed by many that CHARLES M. SCHWAB, or someone acting as his agent, is the likeliest guess.

## Essential Qualifications for Commercial Agents in Latin-America

**T**HERE came to us lately a request to recommend a competent man to travel in certain Latin-American countries with a view to securing information as to the needs of industrial establishments located in those regions. It was required of him that he be conversant with the language of the countries in question, and that he shall "know how to comport himself so as to gain the consideration and confidence" of the persons that he meets, in addition to having a broad understanding of a considerable list of manufacturing processes.

Now it is not difficult to find intelligent men who are familiar with the technical demands of such a position. But when it comes to finding such a man who is conversant with Spanish or Portuguese it becomes difficult. And when it is still further required that he "know how to comport himself so as to gain the consideration and confidence" of Spanish-American men of substance, the difficulty becomes greater still. This is not said in any sense of criticism of American technologists; it is merely a statement of fact based upon more or less local habits of life.

The white population of Central America and parts of South America is but a small minority and yet it is generally in control of the greatest business organizations. White domination such as prevails in our own Southern States is out of the question. For this very reason the white minority feels called upon to maintain habits of grace which are more or less traditional. It is demanded, for instance, as an index of good breeding, that everyone speak French with reasonable fluency. A certain familiarity with *belles lettres* and at least with classic art is expected. More or less ancient conventions

are kept up. The obligation of good manners becomes a family tradition. They have what actors call "the grand manner." To those who are unaccustomed to it, it seems affected; but this, after all, is a matter of taste, and everybody, everywhere, is sensitive to criticism of his taste.

Now, many of our technical schools are so intensely practical that graduates often are not even on terms of amity with their own mother tongue, and those studies known as the humanities are passed by as useless. Modern languages also are neglected. Unusual dignity of bearing is frowned upon as lacking in democracy—and very possibly it is. What our South American cousins seek to demonstrate by the grand manner is not democracy; on the contrary, it is the outward and visible sign of their deference to ancient tradition.

The position of the South American person of circumstance, when a man from North America visits him, is that he would like to "get a line on him," as we say; to find out what sort of person he is. He may or may not know the name of the firm represented; the chances are, at all events, that he knows very little about it. The man who calls is his point of contact. If the latter makes a disagreeable impression he does not want any dealings with him. His business relations he also considers as social affiliations—which often confuses the man from the north. Agreeable persons from abroad are scarce, and they are greatly desired. He wants to deal with somebody who can understand him and his ways, including his likes and dislikes. Things that are negligible to the North American buyer become of leading importance to buyers from South America. Dates of shipment, metric units in packages, the size and shape of single packages, and many other details present themselves as more important even than the price to be paid—with in reasonable limitations. There are a thousand reasons why his unbidden visitor should be to him what he terms *simpatica*.

Again, if anything is thrown at a South American buyer with the statement that he can take it or leave it alone, the chances are preponderant that he will leave it alone. If the visitor lacks the time, or the inclination, or the wit, or the understanding to engage in a couple of hours of conversation, the host is unlikely to be interested in anything he has to say. He will be interested, however, the following week if a competitor who knows how to talk to him comes around. He is not ready to discuss business until he has had a chance to size up his visitor.

But suppose the Latin-American prospective buyer to be half or whole Indian, or suppose him to be tintured by a strain of African—suppose him to be a man who

does not even own a white collar; he will nevertheless set himself up to be a person of circumstance; he will assume that his tastes are similar to those of his white fellow citizens; and he also wants to size up his visitor before negotiations begin. He must know beforehand whether the prospective business connector can think as he does.

For the man who goes to South America to do business, a term at a commercial high school and a course in engineering are not enough. What he needs is polish, *savoir faire*, versatility and at least the semblance of grace. Then he can gain the friendship of the real men of substance and get their trade as well. And he can't get any trade worth seeking if he is a roughneck.

### Pyrometers for Brass And Bronze Makers

**T**EMPERATURE control at various steps in brass and bronze manufacture is generally recognized as being most desirable, since it has been clearly demonstrated that intelligent melting reduces metal losses and heat consumption on the one hand and on the other promotes uniformity in the finished work. With the best will in the world, however, a logical application of present knowledge is difficult because durable pyrometers at once rugged and cheap are still unavailable.

Pyrometers would be very useful to give temperatures of metal in a furnace, and in the ladle; the one stationary, the other portable; both must be rugged. Furnace pyrometers would hardly pay except in furnaces of large capacity, especially if adequate portable indicators for metal in ladle were available. Apparently the most feasible furnace control known at present could be had by a gas-tight tube of graphite or some material which does not crack, dissolve or oxidize readily, this tube being raised during the charging and melting stages, then lowered into the bath and observed by an optical instrument. Such a device could be made extremely rugged, since there is plenty of time to overcome the lag due to heat capacity. It must be made of insoluble materials, however, since it must be arranged so it can be plunged into the metal—a tube in the furnace walls or anywhere else is worthless. Its use undoubtedly would save time and fuel, while giving minimum oxidation and absorption of gas.

Fortunately, modern electric-furnace design with its attendant greater control over temperature will reduce the need for a furnace pyrometer. Thus, on 24-hour operation a given number of kilowatts applied to a given charge for a given time will produce metal of the same temperature on successive heats, while on intermittent operation, the needed power input for each heat can be scheduled.

The second need, which will exist even when the first is solved, is for an instrument which will read temperatures in the furnace just before pouring or in the ladle. Here one must have not only speed but accuracy as well. One minute per ladle amounts to many hours per month; and one cannot wait long when deciding whether metal is just hot enough to pour certain castings without a misrun.

Speed means thermo-elements with small mass, which in turn eliminates refractory non-metallic protection tubes rugged enough to remain long in a foundry. Bare, base-metal couples will give speed, but practically all present analyses are rapidly corroded, and the readings are accurate only when the metal has an absolutely clean

surface and is thoroughly mixed at the instant, since all the immersed portion is short-circuited and it is the temperature of the surface which is indicated. If there is a layer of slag, charcoal or oxide on the metal, the readings are scarcely more dependable than a judgment by eye—optical pyrometry clearly being inadequate.

Speed and accuracy call for metallic tubes of small mass—preferably of an insoluble alloy which could form one leg of the circuit, like the iron tube of the iron-constantan couple so satisfactory for aluminum. The choice of metal is not easy—in fact, it has occupied the attention of the Bureau of Mines alloy chemists for some time. It must have proper thermo-electric properties, it must not be brittle, it must be stiff and strong, it must be insoluble in hot alloys, and be capable of being drawn, cast or welded into thin-walled tubes. Nickel, either pure or alloyed, is very soluble; iron much less so. Pure chromium, molybdenum and tungsten are almost insoluble, but ductile molybdenum and tungsten oxidize just above working temperatures and are very expensive and hard to procure. A perfect chromium plating on a nickel tube would serve excellently, but a single pin hole or scratch ruins the tube. An alloy of 25 per cent chromium, 75 per cent iron, can be cast into moderately thin-walled tubes, but corrodes in rather an erratic manner. Heavy tubes of an iron-chromium analysis have been rather extensively used, but to cut down lag they must be constantly kept at about 1000 deg. C. in a separate furnace of small dimension.

Thus the metallic tube seems to be the crux of the problem—suitable couples and meters are now known. For standardization and experimental work quartz protection tubes were satisfactorily used by the Bureau of Standards, while Dr. GILLET recommends a nickel tube protected by silfrax and tipped with a bare molybdenum nipple. Either of these has its obvious disadvantages and limitations when applied to work on the foundry floor and it is hoped that future research will bring to a successful end the large amount of admirable work already done on the problem of rugged pyrometers for use in brass and bronze. Eventually an insoluble dense alloy which can be drawn or rolled into tubes, or machined into closed end tubes of thin wall section will doubtless be found.

### Declaration of American Policy Toward German Dyes

**A**T THE recommendation of the Advisory Committee on Dyes, the War Trade Board Section of the Department of State has issued a public statement of the policy underlying the present temporary control which is being exercised over the importation of German dyestuffs. On July 26 it was announced that, for the present, no licenses whatsoever are being issued for the importation of any dyestuffs produced or manufactured in Germany. The adoption of a permanent policy affecting the importation of dyestuffs is now being considered by Congress.

Licenses are being issued freely, however, for the importation of all dyestuffs produced or manufactured in non-enemy countries, especially Great Britain and Switzerland. Furthermore, under the provisions of Annex VI of Part VIII of the Treaty of Peace with Germany, which is printed on another page in this issue, German dyestuffs will become immediately available to American consumers under certain restrictions when the treaty comes into effect. Quantities will only



be such as are necessary to meet domestic requirements, and prices will be fixed by the Reparation Commission. Nevertheless, as the result of a careful survey of the present situation in the dye-consuming industries and the unanimous opinion of the Advisory Committee on Dyes, there appears to be no such need for German dyestuffs in the United States as to warrant the issuance of licenses for their importation.

An earlier announcement of the War Trade Board Section on July 20 explained that vegetable dyes of natural origin may be imported without individual license.

### The Shoe on The Other Foot

THE War Department announces that it is offering its surplus stock of platinum for sale at a minimum price of \$105 per ounce. Purchasers may buy not less than 10 ounces or more than 1000 unless the Director of Sales deems it advisable to grant special permission for a sale of larger quantity. Incidentally we note that the Director of Sales has studied the market and method of disposition and has come to the conclusion that the scheme proposed will, as he says, "assure the Government the highest return for its surplus stock and at the same time prove most beneficial to the general public."

Without any intention of being uncharitable or cynical we cannot help recalling the situation of about a year ago when the War Industries Board arbitrarily set a price of only \$90 per ounce on the platinum it confiscated, despite the fact that the market price for over a year and a half previous had been \$105. Can it be that insult is now to be added to injury by offering back, to those from whom it was taken, the same metal at an advance of \$15 per ounce? We fully recognize the fact that the present Director of Sales is not the War Industries Board; also that each may plead zeal in the Government's cause. Beyond that it seems evident that the patriotic citizen is asked to demonstrate the quality of his loyalty to the extent of taking a loss at both ends of the line.

### Steel Production During the War

PRODUCTION of steel ingots and castings, in gross tons, has been as follows, beginning with the two pre-war years, easily the largest tonnage years in the industry before the war:

	Ingots	Castings	Total
1912.....	30,284,682	966,621	31,251,303
1913.....	30,280,130	1,020,744	31,300,874
1914.....	22,819,784	693,246	23,513,030
1915.....	31,284,212	866,824	32,151,036
1916.....	41,401,917	1,371,763	42,773,680
1917.....	43,619,200	1,441,407	45,060,607
1918.....	43,051,022	1,411,410	44,462,432

There was full operation of the steel industry from the late spring of 1912 until the late fall of 1913, and it was merely a coincidence that the ingot tonnages of the two years were almost precisely the same. There was some increase in capacity during the two years. There was no further increase in capacity until the latter part of 1915, while thereafter capacity increased rapidly, as to the making of steel, and as this increase was called for because of the demand for shell steel there was little tendency to increase finishing capacity, except in the one case of plates.

From a consideration of various details it may be

estimated that capacity in steel ingots was about 35,000,000 tons in 1914 and is now about 49,000,000 tons, which would show a war-time increase of precisely 40 per cent. With production in 1912 and 1913 at less than the capacity at the end of 1913, and with production in 1918 interfered with by insufficiency of rail transportation, affecting in particular the supply of coke, and with other difficulties, it chances that the gain in production from 1912-13 to 1918 was 42 per cent, or almost precisely the same as the estimated increase in capacity from 1914 to the present time. In the production of steel castings there was approximately the same gain.

The production of rolled iron and steel in gross tons is shown in the table below. The system used in compiling the statistics is to take the material in its form after its last hot rolling (of course after shearing), whereby billets, sheet bars, etc., are not counted except when they are exported, and then of course they are counted at their weight when exported; rods are counted rather than rod billets or drawn wire, skelp is counted rather than pipe, black plate rather than tin plate, and so on.

	Rolled Steel	Rolled Iron	Total Rolled
1912.....	23,019,259	1,637,582	24,656,841
1913.....	23,112,986	1,678,257	24,791,243
1914.....	17,202,420	1,167,776	18,370,196
1915.....	23,098,091	1,294,833	24,392,924
1916.....	30,557,818	1,822,571	32,380,389
1917.....	31,199,943	1,867,757	33,067,700
1918.....	29,581,778	1,573,976	31,155,754

The increase in rolled steel production from 1912-13 to 1918 was 28 per cent, or much less than the 42 per cent shown for ingots. That, of course, reflects the large production of shell steel in 1918, with heavy cropping of the ingots. Evidently not as much was accomplished as was hoped for by the War Industries Board, in finding rolling uses for shell discard steel. Apparently the great bulk of the material became scrap, or else there was a large stock of ingots at the close of the year, for the proportion of rolled steel to ingots in 1918 was 69 per cent, against a normal of 76 per cent in 1912 and 1913.

The production of rolled iron decreased sharply in 1918 as compared with either of the two preceding years, while the production of ingots was much the same in the three years. The decrease in rolled iron was probably due in part to shortage of scrap, but in part also it was presumably due to lightness of demand. The strictly war demand ran almost entirely to steel and the railroads did not buy as much, either iron or steel, as in previous years. The 1918 rail production, for instance, was only 2,540,892 tons, or about 350,000 tons below the average of 1916-17 and 850,000 tons below the average of 1912-13, yet a large tonnage of rails went abroad in 1918.

The production of sheared plates,  $\frac{1}{4}$ -inch and heavier, amounted to 3,445,284 tons, against a production of 1,432,254 tons in 1913, showing an increase of 2,013,030 tons, or 140 per cent. A negligible tonnage of iron plates is included in the figures mentioned. As several of the new plate mills were not completed until late in 1918, the existing capacity is considerably greater than the production shown for 1918. No new plate mills will be needed for a long time.

The steel industry easily made good its promise in May, 1917, that the country would not be under the necessity of building wooden ships through inability to obtain steel plates.

## Readers' Views and Comments

### Flakes in Nickel Steel Gun Forgings

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the Rochester district during the past two years the Ordnance Inspection Office had considerable trouble with flakes in gun forgings made in that region.

Recently we reviewed all reports of physical tests on guns and classified the data contained. The results are especially interesting in that they compile the tests on approximately 4000 gun forgings in this summary.

Chart No. 1 shows that in forgings made from ingots cast during the months of January, February and March, 1918, over 50 per cent contained flakes. The percentage of flakes decreased continually after Feb-

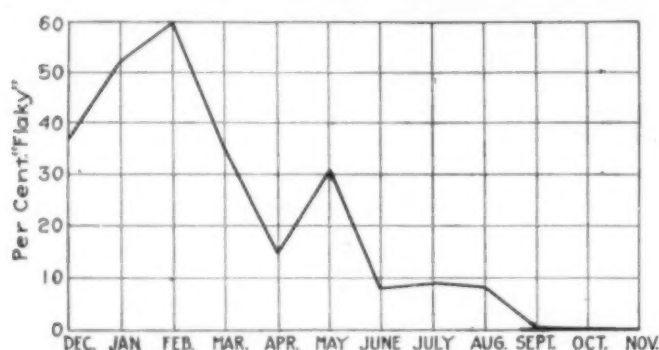


CHART 1.

Curve showing per cent of "flaky" forgings received from one steel plant. Date of casting used in classification. Figures based on results of 3500 forgings.

ruary, and the forgings that were cast in September, October and November showed no signs of this flaw.

Chart No. 2 shows how the percentage of flakes varies with the nickel content. It will be noted that the tenderness of nickel steel and the tendency to flake

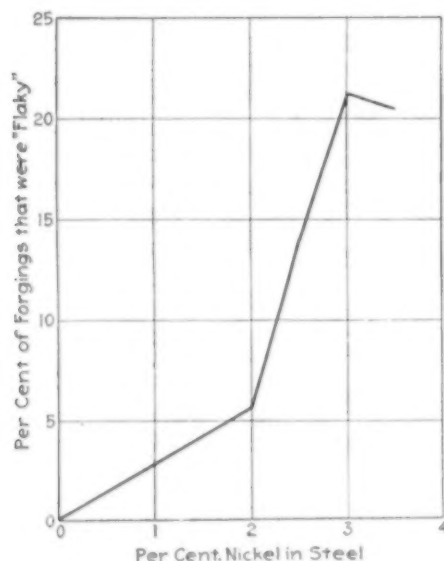


CHART 2.

All forgings with Ni content from 1.75 to 2.25 were grouped together in 2 per cent class. Per cent "flaky" obtained by dividing total showing flake by total in class. Same procedure followed to obtain per cents at 2.5-3.0-3.5 Ni. Figures based on average of 3000 forgings.

increases quite rapidly with the nickel content up to 3 per cent.

Practically all the forgings produced during January,

February and March, 1918, contained 3 to 3.5 per cent nickel. After that time the percentage of Ni was decreased until the forging ingots cast in September, October and November, 1918, were made of either straight carbon steel or steel containing 1 per cent of nickel. A great deal more care was also taken in casting and forging as the seriousness of this flaw was realized.

Dr. H. M. Howe's theory of cracks forming either when the ingot is cooling or when it is forged seems very logical to me. The physical results obtained from test bars seemed the only argument against it. To settle this point in my own mind, I carefully measured the area of several flakes in different bars and subtracted

TABLE I.

Physical Properties Based on Full Area				Physical Properties Full Area Minus Area of Flake	
Ultimate	El. Limit	Per Cent Elong.	Per Cent Red.	Ultimate	El. Limit
87,100	58,300	5.5	14.1	100,500	67,200
60,300	50,000	2.0	7.1	120,600	
83,900	54,000	7.5	22.3	103,600	67,800
62,500		Double fracture		109,500	
73,900	54,800	5.5	10.0	98,500	73,000
94,000	65,000	3.5	9.3	134,000	92,250
84,800	64,000	3.0	10.4	105,000	79,500
94,900	65,000	6.5	17.6	111,500	76,500
76,100	60,000	3.5	16.8	99,500	78,500
88,200	68,000	3.0	14.5	109,000	84,000
83,400	61,800	4.0	11.2	103,000	76,300
81,000	64,000	3.0	3.5	108,000	85,500
79,300	53,100	4.5	10.2	91,000	61,000
81,400	60,000	3.0	8.1	97,000	71,500
73,500	56,000	2.0	5.1	92,000	70,000

this area from the original area of the bar. The figure thus obtained was the actual area of sound metal. I then divided this area into the load at elastic limit and tensile strength. It is to be noted that the tensile strength obtained in this way is not unreasonable in any case. Table I gives the figures for several bars.

I feel that this trouble was due entirely to forced production and that it will disappear entirely now that the need of steel is not so great and more care can be taken in making the steel correctly. Flakes tended to form by heats. However, this was not always the case. Results indicate that the tenderness of the steel is dependent on the conditions under which the steel is made and thus varies from different heats.

RALPH A. HAYWARD.

District Metallurgist,  
Rochester Ordnance Office,  
Rochester, N. Y.

### Electric Brass Melting

To the Editor of Chemical & Metallurgical Engineering

SIR:—May I direct your attention to an error appearing in your issue for July 1, 1919, page 9, wherein you give the power cost for an electric furnace as 0.86 cent per kilowatt-hour. This figure would be correct if all of the 70,000 kw.-hr. used per month was charged to the electric furnaces; but as a matter of fact 20,000 kw.-hr. was used for lights or motors, leaving only 50,000 used directly by the furnace. Accordingly, the equation at the bottom of page 9 should be  $602.5 \div 50,000 = 1.205$ ; also the first line on the top of page 10 should read "The electric furnace cost is 1.205 cents per kw.-hr., and in Table II. p. 10, the power price for the first case is 1.205 cents instead of 0.860.

New York City.

X. Y. Z.



## Western Chemical and Metallurgical Field

### Low-Temperature Distillation

A PROCESS for low-temperature carbonization which has attracted more or less notice in British Columbia has been experimented with at Nanaimo under the auspices of the inventor, Walter Thomas, and a Vancouver firm, McPherson & Fullerton Bros. Originally it was tried on Nicola Valley coal; the products were a semi-coked smokeless fuel, and about 7 gal. of oil per ton of fuel, with little permanent gas. Later work has produced a good dense charcoal from mill waste obtainable for a few cents per cord. In operation, a vertical brick-lined retort some 14 ft. high and 3½ ft. in diameter is filled with coarse material to be carbonized, then closed, and the air contained in the system forced by a fan through a pipe stove and into the top of the retort. This passes down through the mass to be carbonized, thence through a pipe condenser and an electrical precipitator to remove liquid hydrocarbons, and back to the fan for recirculation. As the carbonized fuel becomes hotter, gases will be given off so that after a time rich distillation gas should constitute the circulating medium.

Dr. Stansfield in his recent report on Electric Smelting of Iron Ore in British Columbia presents a short note on this process. He sees many drawbacks to the scheme as it was illustrated to him, such as the difficulty of forcing gas through the field retort, the slow heating of the carbonizing mass by the circulating gases, which are of low temperature and low heat capacity, the inefficiency and expense of the ordinary pipe stove, and the decomposition of hydrocarbon which will take place at this point. He has been assured, however, that enough work has been done to convince the backers of the process that they can make satisfactory charcoal at a cost of about \$5 per ton, in a cycle of operations lasting six hours.

### Magnesite for Flooring Composition

Magnesite trade has been generally very quiet since the signing of the armistice, marking time with the steel industry, the principal consumer. Refractory manufacturers absorb perhaps 85 per cent of the magnesite output in making brick and granular material for steel and copper furnaces, while the balance is used chiefly for flooring. For the latter, both caustic magnesite (carbonate burned down to 2 to 4 per cent CO<sub>2</sub>) and a German magnesium chloride were used before the war. Recently, however, a scarcity of materials has raised the price of high-grade floor compositions to a point where their use is almost prohibitive.

The principal manufacturers of composition flooring have lately organized and instituted a co-operative research at the Pittsburgh laboratory of the Bureau of Standards to determine proper specifications for raw materials, calcination and method of laying the floor. It is hoped that the price can be brought into competition with that of hardwood flooring, when large quantities of it should be used.

As is well known, the principal American deposit is in Washington, where large-scale production is possible under most favorable manufacturing conditions. California deposits are more scattered and not well developed, and will consequently produce but little low-

cost material. Argenteuil County, Quebec, has notable magnesite resources, having shipped 16,700 tons crude ore, and 22,700 tons of calcined material during 1918, of which 80 per cent was exported, mostly to the United States.

### Iron and Steel in Canada in 1918

Canada produced 1,163,520 short tons of pig iron in 1918 from blast-furnaces, including those of the Dominion Iron & Steel Co., at Sydney, N. S.; the Nova Scotia Steel & Coal Co., at North Sydney, N. S.; the Standard Iron Co., at Deseronto, Ont.; the Steel Company of Canada, at Hamilton, Ont.; the Canadian Furnace Co., at Port Colborne, Ont., the Algoma Steel Corp., Ltd., at Sault Ste. Marie, Ont., and the Midland Iron & Steel Co., at Midland, Ont. This production was slightly less than in the two years preceding, but it was augmented by 30,425 tons of electric pig from steel scrap, mostly low-phosphorus pig from shell turnings. Such electric furnaces were operated at Hull and Shawinigan Falls, Que., at Orilla, Collingwood, St. Catharines, Toronto, Belleville, and Bowmanville, Ont., and at Port Moody, B. C. Ferros, chiefly ferrosilicon and a little ferromolybdenum and ferrophosphorus were made in electric furnaces to the extent of 44,700 tons, valued at \$4,730,000, over half of which was exported. Practically all the pig iron was consumed in Canada, however, the amount being slightly increased by a net import of about 65,000 tons.

Steel ingots and direct steel castings amounted to 1,893,000 short tons, of which 73,000 tons were of the latter category. Both of these classifications show a considerable increase over the figures for 1917. Electric steel amounted to 120,000 tons, as compared with 50,000 in 1917 and 61 in 1914. Some 220,000 tons of steel products (exclusive of shell) were exported. Thus Canada is practically self-contained as to iron and steel products of ordinary use.

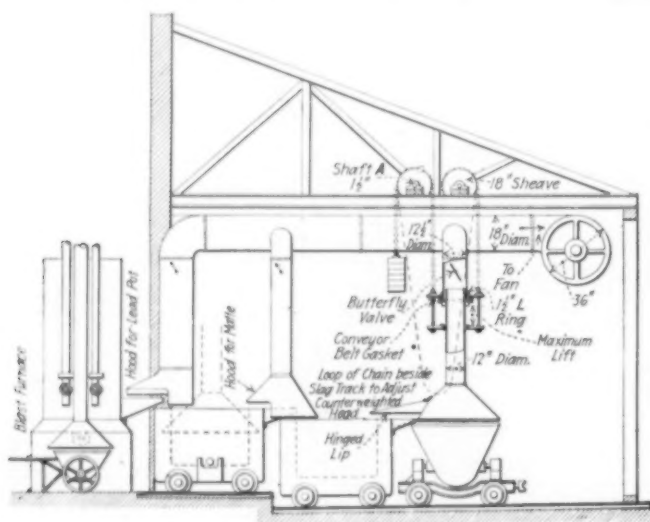
### Electrometallurgical Research Laboratory in San Francisco

A laboratory designed to investigate problems arising in the electric smelting of various kinds of non-ferrous ores has been added to the laboratories of the Beckman & Linden Engineering Corporation at San Francisco, and is now working on a nickel-copper ore which apparently will give a metal of similar character to monel metal. In view of the variety of mineral resources of the West Coast and the large amounts of hydro-electric power which will be available in years to come, the laboratory should prove to be of great help in promoting electrothermic reduction of ores in that region.

The equipment consists of complete electrical appliances to give 100-kw. single-phase current at a voltage range of from 40 to 120, together with proper switch-board and portable instruments for studying the electrical and temperature conditions during operation of a furnace. Semi-permanent furnaces will be erected as required by the study in hand, as is usual in research laboratories of this sort, an ample supply of leads, electrodes, refractories, ladles, molds, sampling equipment, and so on, being held in stock. In addition to this equipment, the laboratory is equipped with a 15-kw. low-voltage motor generator set, with the necessary accessories for studying problems in electrolytic decomposition and deposition.

### Tapping-Floor Ventilators

"Safety-first" movements are responsible for the almost universal installation of ventilating hoods over forehearths and ladles around lead furnaces, for removing smoke perhaps more annoying than dangerous except at the lead well. Some of the installations work but passably, and tempt the furnaceman to neglect them, since they remove so little smoke as to be worth little trouble. He feels that he should not be asked to do anything except keep the lower part of the furnace in operating order, and such extra frills must be practically foolproof and automatic if they are to remain in operation. Even in the best installations which keep the tapping floor practically free from



SKETCH OF HOOD SYSTEM FOR LEAD FURNACE

smoke, it is almost impossible to get workmen to close a damper in the matte-pan hood during the time it is not needed and thus save draft; if, on the other hand, stoppage of the fan throws the entire system out of order, they pour out of the building and vociferously demand more speed in repairing a condition they would have accepted as part of the job ten years ago.

Herewith are sketched some ideas observed in a successful hood system at a furnace using two forehearths in series. Since these crust over with chilled slag soon after being replaced, it is only necessary to hood the spouts and a small area where the slag enters. Furnacemen will keep these hoods somewhat high so that the outer air drawn in around the cages will not burn too quickly the wood placed on the spouts to keep them open, so extra clearance should be allowed at these places. One side of the hood at the furnace should also be cut back as shown, so that the tap-hole may be opened and closed without continual adjustment.

A complete system will involve hoods closely covering the lead pot, the matte pan and the slag pot, as well as two for the spouts to settlers No. 1 and No. 2. Each is closely counterweighted so it can be easily raised out of the way, by a rugged mechanism somewhat like that indicated, the lower pipe, smooth outside, telescoping into the upper part through a flap of conveyor belting, simple stops limiting the travel. Shaft A, for instance, is extended a sufficient distance to carry a guarded sprocket so that a loop of light chain can hang down to a handy point on the floor, easily reached and yet not interfering with ordinary furnace work. A like arrangement actuates a butterfly valve in each pipe, its

position, whether open or shut, being shown by an arrow at the side of the pipe.

Exhaustion is effected by a fan capable of handling 6000 cu.ft. per min. per furnace; a draft of about  $1\frac{1}{2}$  in. at the fan will usually be sufficient. The very dilute smoke is discharged into the main blast-furnace flue, and the values recovered. As noted before, the fume rising from the lead pot is dangerous, the dense sulphur fumes from the matte pan quite irritating, while the mixed smoke from a slag stream is disagreeable from its volume and heat.

### Exposition Plans and Exhibitors

THE Fifth National Exposition of Chemical Industries, which will be held in Chicago during the week of Sept. 22, promises to be of exceptional interest, since many of the inventions and developments made under the stress of war-time necessity will be shown publicly for the first time. As instances, we may mention: acid and alkali proof bronzes, prepared for specific purposes that even quite recently were unheard of; bronze of such hardness and strength that instruments made of it are used to cut chilled steel; technical organic products developed for waterproofing and fireproofing; instruments perfected during the war for precise measurements of temperatures, weights, volumes, velocities, flow of liquids, gases, electric currents, etc.

A feature of the exposition will be the exhibits of electric furnaces, which will include the Rennerfelt furnace, handled in America by Hamilton & Hansell; the Bailey furnace, by the Electric Furnace Co.; the Taylor furnace, by the Industrial Electric Furnace Co.; the Detroit Rocking furnace, by the Detroit Electric Furnace Co., the furnace of the Booth-Hall Co., and many others.

The Bureau of Mines will show the complete course of extraction of some thirty metals from their ores, together with the materials used in the extraction. In addition, the Bureau will have a collection of protective and safety devices, such as goggles, shields, masks, hoods, oxygen helmets, etc., and will hold a symposium upon "Safety in the Plant and Mine," with speakers of authority in this work, under the chairmanship of M. L. Leopold, safety engineer of the U. S. Bureau of Mines. In the evening after this meeting, which will occupy an entire afternoon, there will be shown a series of motion pictures of safety work in plant, field and mine—pictures now being made in industrial plants all over the country under the supervision of Government agents.

The Forest Products Laboratory of the Forest Service will make an exhibit of the work it has been conducting on processes, raw material, products, by-products, etc. Among the subjects will be the investigation on pulp and paper, ethyl alcohol from wood waste and sulphite liquor, the increased production of acetate of lime in hardwood distillation, and the naval stores investigations.

The Technical Association of Pulp and Paper Industry is planning an exhibit showing all the phases and stages in paper making from the tree to the finished paper, including illustrations of the machinery through which pulp passes in all stages.

The Bray Studios will endeavor to show, by means of animated drawings, the mechanism of certain chemical actions usually invisible to the eye and only conceived



by the mind in abstract form. The following partial list of exhibitors indicates clearly the scope of the Exposition:

Abbe, Paul O.  
Abbe Engineering Co.  
Abbott Alkaloidal Co.  
Abbott Laboratories  
Airsouth, Wm., & Sons  
Albany Felt Co.  
Alberene Stone Co.  
Allen Electrolytic Cell Corp.  
American Chemical Society  
American Chemical & Mfg. Co.  
American Ceramic Society  
American Cyanamid Co.  
American Electrochemical Society  
American Hard Rubber Co.  
American Iron Scale Co.  
American La France Fire Engine Co.  
American Limestone Co.  
American Meter Co.  
American Transformer Co.  
American Water Softener Co.  
Anaconda Copper Mining Co.  
Annel H. Reeve & Co., Inc.  
Aniline Dyes & Chemical, Inc.  
Arkell Safety Bag Co.  
Armstrong Cork Co.  
Arnold Hoffman & Co., Inc.  
Ariston, W. O., Mch. Co.  
Austin Co.  
Bachmeier & Co., Inc.  
Bailey Meter Co.  
Baker, J. T., Chemical Co.  
Barrett Co., The  
Bavich & Lomb Optical Co.  
Beach-Russ Co.  
Becker Christian Inc.  
Beckley Perforating Co.  
Beiphlee Elec. Co.  
Blackmer Rotary Pump Co.  
Blair Campbell & McLean, Inc.  
Round Brook Chemical Co.  
Bayer Oil Co.  
Bayer Oil Mfg. Co.  
Bristol Co., The  
Brown Instrument Co.  
Brown Portable Conveying Mch. Co.  
Buffalo Fdry. & Mch. Co.  
Butterworth-Judson Corp.

Canada Carbide Co.  
Canadian Chemical Journal  
Canadian Electrode Co.  
Canadian Electro Products Co.  
Carborundum Co., The  
Carnotite Reduction Co.  
Carrier Engineering Co.  
Celite Products Co.  
Celluloid Zapon Co.  
Central Scientific Co.  
Challenge Co.  
Chemical Construction Co.  
Chemical Engineer  
Chemical Equipment Co.  
Chemical & Metallurgical Eng.  
Chemical Catalogue Co., Inc.  
Cleveland Cliffs Iron Co.  
Climchfield Products Corp.  
Contact Process  
Coors Chemical Porcelain Co.  
Cornish Glass Works  
Crane Co.  
Crane Packing Co.

Daigger, A., & Co.  
Day, J. H. Co., Inc.  
De Laval Separator Co.  
Denver Fire Clay Co.  
Detroit Electric Furnace Co.  
Detroit Range Roller & Steel Bbl. Co.  
Devine, J. P., Co.  
Diamond State Fibre Co.  
Dings Magnetic Separator Co.  
Dorr Co., The  
Dow Chemical Co.  
Drackett, P. W., & Sons Co.  
Duriron Castings Co.  
Dunk Tank Works

Eagle Tank Co.  
East Iron & Machine Co.  
Economic Machinery Co.  
Edgar Bros. Co.  
Egyptian Lacquer Mfg. Co.  
Eimer & Amend  
Electric Furnace Co.  
Electro Bleaching Gas Co.  
Electrolytic Engineering Corp.  
Electron Chemical Co.  
Elmore, G. H.  
Elyria Enamelled Products Co.  
Empire Laboratory Supply Co.  
Engelhard, Charles  
Everlasting Valve Co.

Fansteel Products Co., Inc.  
Fibre Making Processes, Inc.  
Fleisher, W. L., & Co., Inc.  
Fletcher Works  
Foamite Firefoam Co.  
Foote Mineral Co.  
Forest Products Laboratory  
Foxboro Co., The, Inc.  
Fuller Lehigh Co.

Gaertner, W., & Co.  
Garrigue & Co., Wm.  
Garrigues & Co., Chas. F.  
General American Tank Car Corp.  
General Bakelite Co.  
General Ceramics Co.  
General Chemical Co.  
General Electric Co.  
General Fire Extinguisher Co.  
General Filtration Co., Inc.  
Glamorgan Pipe & Fdry. Co.  
Glens Falls Mch. Works  
Gordon Engineering Co.  
Goulds Mfg. Co.  
Groh Centrifugal Flotation Co.  
Gründler Patent Crusher & Pulv. Co.  
Guernsey Earthenware Co.

Hamilton & Harsell, Inc.  
Hanovia Chem. & Mfg. Co.  
Hauzer Stander Tank Co.  
Hardine Conical Mill Co.  
Haynes Stellite Co.  
Hemingway, Frank, Inc.  
Hepworth Co., S.S.  
Hercules Engineering Corp.  
Hercules Powder Co.  
Herold China & Pottery Co.  
Hood, B. Mifflin, Brick Co.  
Hooker Electrochemical Co.  
Hoekins Mfg. Co.  
Huff Electrostatic Separator Co.  
Hunter Dry Kiln Co.

Industrial Electric Furnace Co.  
Industrial Filtration Corp.  
Innis Speiden & Co.  
Irving Iron Works Co.  
Irving National Bank

Jewell Polar Co.  
Journal of Commerce & Commercial  
Bulletin  
Journal of Industrial & Engineering  
Chemistry  
Johnson & Carlson

Kenart Synthetic Products Co.  
Kewaunee Mfg. Co.  
Knight, Maurice A.  
Knoxville Board of Commerce  
Koppers Co., H.  
Koppers Products Co.

Lead Lined Iron Pipe Co.  
Leeds & Northrup Co.  
Lindsay Light Co.  
Liquid Carbonic Co.  
Little, Arthur D., Inc.  
Lungmotor Co.  
Lungwitz, Emil E.

MacBeth Evans Glass Co.  
Machinery Utilities Co.  
Magnetic Mfg. Co.  
Manufacturers Record  
Marden Orth & Hastings Corp.  
Mathieson Alkali Works, Inc.  
McGraw-Hill Co., Inc.  
Mead & Co.  
Merck & Co.  
Metals Disintegrating Co.  
Miner, Edgar, Co.  
Mineral Point Zinc Co.  
Mojonnier Bros. Co.  
Mott, J. L., Iron Works

Nassau Valve & Pump Corp.  
Nash Engineering Co.  
National Aniline & Chem. Co., Inc.  
National Filter Cloth & Weaving Co.  
Nelson, Alfred W., Co.  
New Jersey Zinc Co.  
Newark Wire Cloth Co.  
Newport Chemical Works, Inc.  
Niagara Alkali Co.  
Niagara Electro Chemical Co.  
Nitrogen Products Co.  
Norton Co.

Ohio Pottery Co.  
Oil, Paint & Drug Reporter  
Oliver Continuous Filter Co.  
Ontario Bureau of Mines  
Organic Salt & Acid Co.

Parks-Cramer Co.  
Pennsylvania Salt Mfg. Co.  
Permutit Co.  
Peterson, Leonard & Co.  
Pfaudler Co.  
Philadelphia Drying Mch. Co.  
Philadelphia Quartz Co.  
Philadelphia Textile Mch. Co.  
Pneumercator Co.  
Pratt Eng. & Mch. Co.  
Precision Instrument Co.  
Precision Thermometer & Inst. Co.  
Product Sales Co.  
Provost Engineering Corp.  
Pyroelectric Instrument Co.

Quigley Furnace Specialty Co.

Raymond Bros. Impact Pulv. Co.  
Raritan Copper Co.  
Redmanol Chemical Products Co.  
Republic Flow Meters Co.  
Research Corporation  
Research Laboratory of Chicago  
Revolutor Co.  
Roessler & Hasslacher Chem. Co.  
Rollin Chem. Co.  
Rossendale-Reddaway Belting & Hose  
Co.  
Ruth Co., The

Sarco Co., Inc.  
Sargent, E. H., & Co.  
Schaar & Co.  
Schaeffer & Budenberg Mfg. Co.  
Schutte & Koerting Co.  
Schwartz Sectional System  
Scientific Equipment Co.  
Scientific Materials Co.  
Scott & Co., Ernest  
Semet Solvay Co.  
Sharples Specialty Co.  
Shawinigan Electro Metals Co.  
Shawinigan Water & Power Co.  
Sherwin Williams Co.  
Sly, W. W. Mfg. Co.  
Soderking, Walter, Inc.  
Solvay Process Co.  
Sowers Mfg. Co.  
Sperry Co., D. R.  
Star Brass Works  
Stein Hall & Co., Inc.  
Stokes, F. J., Mch. Co.  
Stresen-Reuter & Hancock, Inc.  
Sturtevant Mill Co.  
Sullivan Machinery Co.  
Sunbeam Chem. Co.  
Swedish Crucible Steel Co.  
Swenson Evaporator Co.

Tagliabue, C. J., Mfg. Co.  
Tank Equipment Co.  
Taylor Instrument Companies

Technical Products Co.  
Texas Gulf Sulphur Co.  
Thermal Syndicate Co., Ltd.  
Thermo Electric Instrument Co.  
Thomas, Arthur H., Co.  
Thwing Instrument Co.  
Tolhurst Machine Works  
Tower & Wooden Tank Industrial  
Council  
Union Sulphur Co.  
Union Thermometer Co.  
United Filters Corp.  
United Lead Co.  
United Lined Tube & Valve Co.  
U. S. Bureau of Mines  
U. S. Cast Iron Pipe & Fdry. Co.  
U. S. Industrial Alcohol Co.  
U. S. Industrial Chem. Co.  
U. S. Stoneware Co.  
U. S. Wind Engine & Pump Co.  
Universal Oil Co.

Valley Iron Works Co.,  
Appleton, Wis.  
Valley Iron Works,  
Williamsport, Pa.  
Van Schaack Bros. Chem. Works  
Virginia Smelting Co.  
Vitroous Enameling Co.

Wallace & Tiernan Co., Inc.  
Wedge Mechanical Furnace Co.  
Welch, W. M., Mfg. Co.  
Wendnagel & Co.  
Werner & Pfeleiderer Co.  
Western Reserve Chemical Co.  
Westinghouse Elec. & Mfg. Co.  
Whitall Tatum Co.  
White, J. G., Engr. Corp.  
Whitlock Coil Pipe Co.  
Wilson-Macaulen Co.

Zapon Leather Cloth Co.  
Zaremha Co.  
Zavon, Inc.

## Status of the Domestic Magnesite Industry

AT A tariff hearing before the House Ways and Means Committee on June 16 and 17, 1919, it was testified that before the war 95 per cent of the magnesite consumed in this country was imported from Austria and that since then most of it has been produced from mines located in California and in Washington State.

In 1914 the cost of imported dead-burned magnesite at Atlantic ports was between \$16 and \$17 a short ton, and the brick made from this material sold for \$112 a thousand, 9-in. standard basis. The cost of dead-burned domestic magnesite, at the time of the hearing, at Atlantic ports was \$49.10, and brick made from this material was bought for \$400 a thousand. As much as \$600 a thousand was paid during the war.

The amounts imported are shown in Table I and the domestic production in Table II.

The domestic magnesite is procured from deposits in California, where it occurs in an amorphous form in veins of varying size, and from deposits in Washington State, where it occurs in a crystalline form in large massive deposits similar to limestone. The development of the California deposits is shown in Table III. The Washington deposits were not developed until 1917. During the year 1918 two companies produced 105,175 short tons crude magnesite from the deposits located at Chewelah and Valley. The known reserves in this country are 8,000,000 tons, the deposits of southern Europe are estimated to contain between 120,000,000 and 130,000,000 tons.

The request of the producers for a protective tariff is incorporated in bill H. R. 5218 as follows:

A BILL To provide revenue for the Government and to establish and maintain the production of magnesite and manufactures thereof in the United States.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That on and after the day following the passage of this act, there shall be levied, collected and

paid upon the articles named herein, when imported from any foreign country into the United States or into any of its possessions, the rates of duties which are herein prescribed, namely:

1. Magnesite, commercial ore, either crushed or ground, three-fourths of a cent per pound.

2. Magnesite, calcined, dead burned and grain, 14 cents per pound.

3. Magnesite brick, 25 per centum ad valorem.

SEC. 2. That paragraph 539 of the tariff act of Oct. 3, 1913, is hereby expressly repealed; and that so much of paragraph 71 of said tariff act and of any heretofore existing law or parts of law as may be inconsistent with this act are hereby repealed.

The testimony of the witnesses at the hearing is conflicting; consumers of brick made from domestic magnesite claimed it to be inferior to brick made from Austrian magnesite, the life of the domestic product being between 60 and 80 per cent of the foreign. H. F. Wierum, general manager of the American Mineral Production Co., at Valley, Wash., claimed that brick made from a dead-burned magnesite produced at his plant was equal to brick made from Austrian magnesite.

TABLE I—IMPORTS OF MAGNESITE CALCINED, NOT PURIFIED, FOR FISCAL YEARS ENDING JUNE 30, 1912-17, BY COUNTRIES, IN SHORT TONS

Country	1912	1913	1914	1915	1916	1917
Europe:						
Austria-Hungary.....	99,104	163,715	109,797	10,997	.....	.....
Belgium.....	25	.....	11	.....	.....	.....
Germany.....	689	2,412	912	307	.....	.....
Denmark.....	.....	.....	103	.....	.....	.....
Greece.....	114	1,605	4,631	9,560	6,346	.....
Italy.....	.....	.....	22	688	.....	.....
Netherlands.....	2,410	4,508	4,717	2,706	235	.....
Norway.....	163	.....	.....	22	.....	11
United Kingdom:						
England.....	61	1	129	.....	2	25
Scotland.....	.....	.....	64	242	593	833
North America:						
Canada.....	234	350	197	2,543	2,094	3,092
Mexico.....	81	.....	.....	.....	.....	.....
South America, Venezuela	.....	.....	.....	508	.....	.....
Asia:						
British East Indies.....	57	.....	.....	.....	.....	.....
British South Africa.....	.....	.....	.....	.....	.....	2
Total.....	102,938	172,591	120,583	27,573	9,270	3,963

TABLE II—QUANTITY AND VALUE OF CRUDE MAGNESITE PRODUCED IN THE UNITED STATES, 1891-1918, IN SHORT TONS\*

	Quantity	Value		Quantity	Value
1891.....	439	\$4,390	1905.....	3,933	\$15,221
1892.....	1,004	10,000	1906.....	7,805	23,415
1893.....	704	7,040	1907.....	7,561	22,683
1894.....	1,440	10,240	1908.....	6,587	19,761
1895.....	2,220	17,000	1909.....	9,465	37,860
1896.....	1,500	11,000	1910.....	12,443	74,658
1897.....	1,143	13,671	1911.....	9,375	75,000
1898.....	1,263	19,075	1912.....	10,512	84,096
1899.....	1,280	18,480	1913.....	9,632	77,056
1900.....	2,252	19,333	1914.....	11,293	124,223
1901.....	3,500	10,500	1915.....	30,499	274,491
1902.....	2,830	8,490	1916.....	154,974	1,393,693
1903.....	3,744	10,595	1917.....	316,838	2,899,818
1904.....	2,850	9,298	1918 (estimated)	225,000	.....

\* From Mineral Resources, 1914-17.

TABLE III—CRUDE MAGNESITE PRODUCED IN CALIFORNIA, 1913-17\*

Year	Producing Mines	Quantity, Short Tons	Value
1913.....	1	9,632	\$77,056
1914.....	6	11,293	124,223
1915.....	16	30,499	274,491
1916.....	45	154,259	1,388,331
1917.....	65	211,663	2,116,630

\* From Mineral Resources, 1917.

The difference between the Austrian and the domestic magnesite is principally in the amount of hematite present.

At the Valley plant magnesite and hematite are ground to 200 mesh. After being thoroughly mixed in the proper proportion the mixture is fed into a revolving kiln 165 ft. in length. The temperature in the hot zone of the kiln is 2900 deg. F., which insures perfect fusion; the product is homogeneous. Material manufactured under these conditions has been produced since

March this year, and brick made from this product has been as satisfactory as those made from Austrian magnesite. This plant seems to be the only one that has made an intelligent effort to produce a dead-burned magnesite which will produce a satisfactory brick, and it is probable that co-operation between the producer of dead-burned magnesite and the manufacturers of brick will lead to more satisfactory results.

## Ways and Means Committee Acts on Tariff Bills

THERE is a safe majority among the members of the Committee on Ways and Means of the House of Representatives opposed to the licensing system. This fact developed at the first meeting of the committee to consider the evidence submitted at the hearings which had been conducted on various commodities which were most in need of safeguarding. The opposition to the licensing system does not extend to that suggested for the dyestuff industry, in which it is practically certain that a licensing plan must supplement the duty.

At its meeting, the committee reported favorably, without amendment, the bill introduced by Representative Timberlake, of Colorado, providing duties on tungsten. The rate of duty on crude tungsten, ores and concentrates, as provided by the bill, is \$10 per unit. Metallic tungsten and the various tungsten products and salts, including manufactured materials containing tungsten, are to pay duty at the rate of \$1 per lb. The vote on the bill was along party lines, with the exception of Representative Martin, of Louisiana, a Democrat, who voted with the Republicans. The Democrats favor the licensing plan, rather than a tariff.

The committee also reported favorably Representative Bacharach's bill providing duties on laboratory glass and porcelain ware, optical glass, scientific and surgical instruments. The rates of duty prescribed under the bill are as follows:

Glasswares and porcelain wares, laboratory apparatus, and other apparatus and appliances wholly or in part of glass or porcelain, for use in the sciences or in analyzing or testing or for use in education, 60 per centum ad valorem.

Optical glass in any and all forms of glass for use in optical instruments or for any optical purposes, and all instruments and appliances of any and all kinds containing parts of optical glass or used for optical purposes, finished or unfinished, 45 per centum ad valorem.

Philosophical, scientific, and laboratory apparatus, utensils, instruments, and appliances and parts thereof, finished or unfinished, and preparations, including bottles and boxes containing the same, not otherwise provided for, 45 per centum ad valorem.

Surgical and dental instruments, or parts thereof, made wholly or in part of iron, steel, copper, brass, nickel, aluminum, or other metal, finished or unfinished, 60 per centum ad valorem.

### DYES, POTASH AND MAGNESITE STILL UNDER CONSIDERATION

The committee, at this writing, still has under consideration the dyestuffs bill and the potash bill, as well as that providing a duty on imports of magnesite. It is believed that the committee is likely to report out substantially the revised Longworth dye bill. In addition to specifying a free list and providing a rate of tariff for the dutiable list, the bill provides for a dye licensing commission as outlined in our issue for July 15, p. 65. The commission shall issue licenses for such dyes as may be unobtainable from domestic sources and shall limit importations as nearly as possible to quantities required by current needs in the United States.



One of the developments of the situation is that the Tariff Commission is very much opposed to administering any licensing system. It came to the ears of the Commission that it had been suggested as the proper body to administer the licensing machinery, and the result was that the Commission not only reiterated its opposition to most of the licensing suggestions, but emphatically urged that it not be selected to administer any of the licenses.

Dr. Hoyt S. Gale of the Geological Survey, in testifying this week before the House Ways and Means Committee, said that the German potash industry could not regain the position it held before the war. The increased cost of labor and the internal condition of the industry, he said, were such that German potash would have to sell for at least \$1.50 per unit.

Dr. Gale returned to Washington last week from Europe, where he made a study of the potash industry, and it was at the special request of Secretary Lane that the Ways and Means Committee summoned him to testify.

W. E. Sharp, president of the Western Potash Works and of the American Potash Co. of Lincoln, Neb., denied to the Committee that the potash industry of this country was controlled by the packers. He admitted, however, that one company was owned by the packers, but said that the products of that company were used by the owners in the manufacture of fertilizer.

The hearings on potash and dyestuffs before the House Ways and Means Committee will not be resumed until after the House recess, Sept. 8.

### International Exposition of Mining Industries

A permanent exhibit of mining and metallurgical machinery is to be established under the direction of the Merchants and Manufacturers Exchange of New York, which has taken over Grand Central Palace for the purpose of maintaining industrial exhibits of various kinds. Approximately 50,000 sq.ft. of space, or one entire floor, will be devoted to the machinery and supplies used in the development and operation of metal mines, non-metal mines, coal mines and oil wells; subsequent extraction or refining of the raw products by concentration, leaching, cyaniding, flotation, smelting, distillation, coking, etc.

The new enterprise enjoys unusual support in the backing of the Nemours Trading Corporation, of which Alfred I. duPont is president. The corporation owns and controls the Merchants and Manufacturers Exchange of New York and has branches in the leading cities of the world consisting of 19 branch offices and 3000 foreign selling agents. The purpose and function of the venture are to develop both foreign and domestic trade in all lines of industry and to establish at a central point a permanent exhibit of machinery and products for the benefit of foreign and domestic merchants.

The exhibit of mining industries will include aerial and surface transportation, laboratory appliances and supplies, blast-furnaces and other ore-treating equipment, compressors, crushers, concentrating machinery, hoists, drills, power machinery, ventilating equipment, etc. The exhibition will be under the direct management of Mr. Howard R. Ward, a mining engineer who prior to entering war work was for three years consult-

ing mining engineer for the American International Corporation. The present headquarters of the International Exposition of Mining Industries is Room 421, 405 Lexington Ave., New York.

### Peace Treaty Provisions Regarding German Dyes and Chemicals

The War Trade Board Section of the Department of State quotes, for the information of those concerned, the following provisions of the Treaty of Peace relative to German dyes and chemicals:

#### ANNEX VI

1. Germany accords to the Reparation Commission an option to require as part of reparation the delivery by Germany of such quantities and kinds of dyestuffs and chemical drugs as the Commission may designate, not exceeding 50 per cent of the total stock of each and every kind of dyestuff and chemical drug in Germany or under German control at the date of the coming into force of the Treaty.

This option shall be exercised within sixty days of the receipt by the Commission of such particulars as to stocks as may be considered necessary by the Commission.

2. Germany further accords to the Reparation Commission an option to require delivery during the period from the date of the coming into force of the present Treaty until Jan. 1, 1920, and during each period of six months thereafter until Jan. 1, 1925, of any specified kind of dyestuff and chemical drug up to an amount not exceeding 25 per cent of the German production of such dyestuffs and chemical drugs during the previous six months period. If, in any case the production during such previous six months was, in the opinion of the Commission, less than normal, the amount required may be 25 per cent of the normal production.

Such option shall be exercised within four weeks after the receipt of such particulars as to production and in such form as may be considered necessary by the Commission; these particulars shall be furnished by the German Government immediately after the expiration of each six months period.

3. For dyestuffs and chemical drugs delivered under paragraph 1, the price shall be fixed by the Commission, having regard to pre-war net export prices and to subsequent increases of cost.

For dyestuffs and chemical drugs delivered under paragraph 2, the price shall be fixed by the Commission, having regard to pre-war net export prices and subsequent variations of cost, or the lowest net selling price of similar dyestuffs and chemical drugs to any other purchaser.

4. All details, including mode and times of exercising the options, and making delivery, and all other questions arising under this agreement shall be determined by the Reparation Commission; the German Government will furnish to the Commission all necessary information and other assistance which it may require.

5. The above expression "dyestuffs and chemical drugs" includes all synthetic dyes and drugs and intermediate or other products used in connection with dyeing, so far as they are manufactured for sale. The present arrangement shall also apply to cinchona bark and salts of quinine.

### German-Owned Chemical Plants Sold

The largest single day's sale of German-owned property was made at public auction on July 18 by the Alien Property Custodian. The sale of three chemical plants brought \$4,419,980. The successful bidders were W. E. Coffin & Co. and the American Aniline Products, Inc., of 80 Fifth Ave., New York.

The Roessler & Hasslacher Chemical Co., of 100 William Street, New York City, with plants at Perth Amboy, N. J., and St. Albans, W. Va., was bought in at \$505 a share. The stock of the Niagara Electro Chemical Co. sold at \$4000 a share, the total price being \$440,000. The concern has offices at 100 William Street, New York, and plants at Perth Amboy, N. J., and Niagara Falls, N. Y. The Perth Amboy Chemical Co. stock went for \$940,800, or \$480 a share.



FIG. 1. GENERAL VIEW OF PLANT OF MINNESOTA BY-PRODUCT COKE CO., ST. PAUL, MINN.

From the left are: Coal crushing tower, stack, housing for inclined coal conveyor from coal dumping building in center foreground to top of the coal crushing tower, housing for inclined coal conveyor from bottom of coal crushing tower to top of coal storage bins at end of Battery B, from which bins the larry car is loaded with coal to be charged into the ovens. In the left-hand background are the two batteries totaling 65 ovens. To right of battery storage bins in order are: By-product buildings, rich and lean gas holders, final gas coolers and light oil scrubbers.

## The Coking of Illinois Coal in Koppers Type Oven\*

An Operating Test at the St. Paul Plant of Minnesota By-Product Coke Company Conducted Jointly  
by the National Bureau of Standards and the United States Bureau of Mines  
for Coking Orient, Franklin County, Ill., Coal

By R. S. McBRIDE† AND W. A. SELVIG‡

THE great importance during the war period of substituting Mid-Continent coal for coals from more distant sources even in by-product coke-oven work was well recognized. The Bureau of Standards was ordered to conduct an investigation of a new coke-oven process claimed to be especially suited to this purpose, and in connection with this the Bureau was requested to conduct a test of the St. Paul plant of the Minnesota By-Product Coke Co., which is owned by the Koppers Co., Pittsburgh. The Bureau of Standards, in co-operation with the Bureau of Mines, carried out this operating test, using during 7½ days about 7700 tons of coal from the Orient Mine, Franklin County, Illinois.

The plant is usually operated with a mixture of Pittsburgh, Elkhorn and Pocahontas coal at normal coking times of about 16 and 17 hr. The normal capacity of the plant is approximately 1100 tons of coal per day. For the test period only Orient coal was used. Since the coking time for this coal was slightly longer than for the usual mixture, the capacity of the plant was reduced somewhat.

All phases of coal handling, by-product recovery and laboratory tests were under observation by the staff of

37 Government engineers and chemists employed on the work. In addition, those in charge had the benefit of advice and comment from a considerable number of experts who are specialists in the field of coke-oven operation. The quantity of all coal used and of all by-products obtained was carefully weighed or measured at regular intervals and samples of each material were taken for analysis. The Bureau of Standards was responsible for the general planning and supervision of the test work. Its representatives made all observations of battery operation, high temperature measurements, by-product recovery, and chemical laboratory work on gas and by-products. The Bureau of Mines was responsible for the sampling of the coal both as it was loaded at the mine and as crushed at the plant. It supervised the weighing, coal-handling, coke-handling and coke-sampling operations and made all analyses of coal and coke. Its representatives also made general observations on the character of the coke and operation of the ovens.

The Minnesota By-Product Coke Company plant consisted of 65 ovens, built with a gross regenerative system, operating during the test period with an average gross coking time of 19 hr. and 33 min., with coal finely pulverized, 12.75 tons per oven as charged. Each oven was 39½ ft. long, 9½ ft. high, 17 in. wide at the pusher side and 19½ in. at the coke side, making a 2½-in. taper with an average width of 18½ in. The coke was

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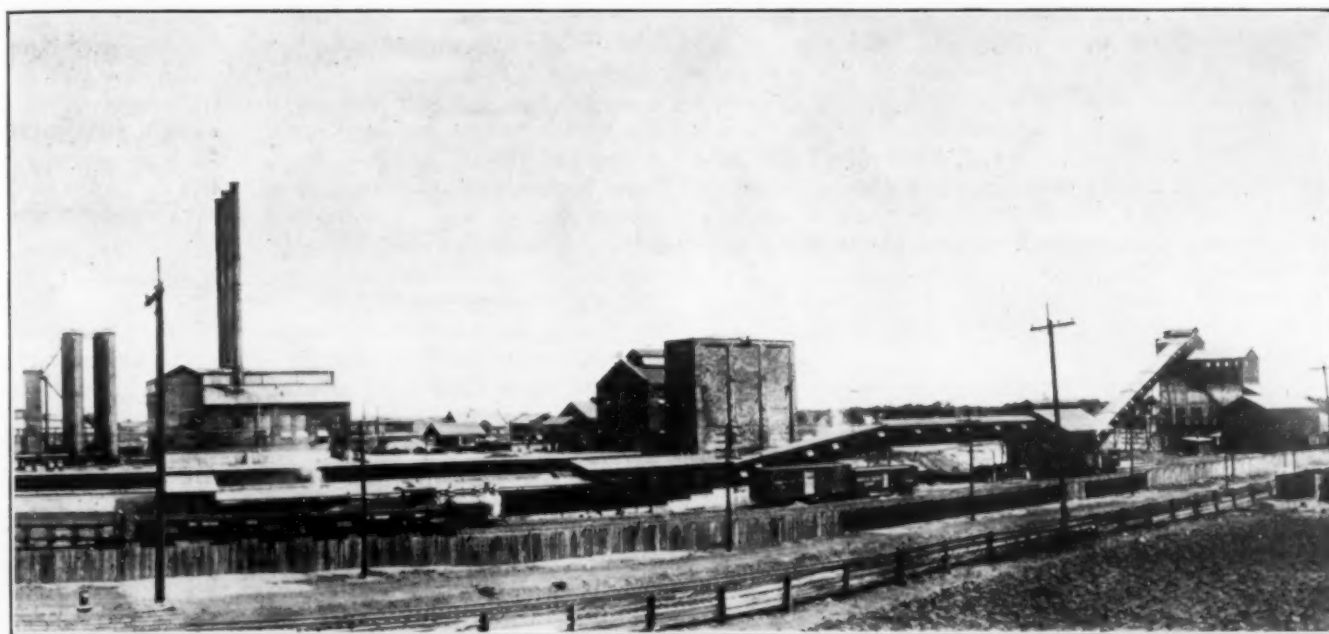


FIG. 2. GENERAL VIEW OF PLANT (CONTINUED)

In the foreground from left to right are shown: Coke wharf, housings for the coke conveyors, the first screening station where large furnace coke is separated from run of oven coke, and the housing for the inclined coke conveyor to final screening station, where the coke is further separated into small furnace and domestic sizes. In the background are the final gas coolers and light oil scrubbers, shown also in Fig. 1, the power plant, laboratory, complete light oil refining buildings, and coke-quenching station.

discharged from the ovens by the usual style of ram pusher into the common form of hot coke car and quenched in a tower of the usual kind. After discharge on the wharf it was handled by a typical conveyor system through two screening stations. The coke was screened to produce large and small furnace sizes; stove, nut and pea, domestic sizes and breeze. The gas was separated into rich and lean at the battery. Separate test records were kept of each size of coke and of each quality of gas. Practically all of the ammonia produced was made up into sulphate immediately through the direct recovery process. Although the plant operated for the production of pure light-oil products, only the total production of light oil was measured, but the yield of various constituents was determined by analysis.

#### COAL USED

The coal was apparently clean and very well screened. The impurities consisted of a small amount of pyrite, mostly in the form of thin layers, calcite, mother of coal, and shale. The coal was crushed at the plant with the intention of making it as fine as was feasible with the apparatus available. As charged to the ovens, over 95 per cent passed through a 4-mesh sieve, and about two-thirds passed through a 10-mesh sieve.

A composite sample of the crushed coal sampled from the conveyor belt was made up from the daily plant samples and analyzed according to the laboratory methods described in Bureau of Mines Technical Paper No. 8; the results are presented in Table I.

In Table II is given the total amount of coal used and the average coking time for the period of the test.

#### PUSHING AMPERAGE

No consecutive record was maintained of the current necessary to push the oven charges. However, sufficient data were obtained to show that, in general, the charges pushed easily, though not as easily as with the usual coal mixture. It generally required from 180 to 250 amp. to start the charge and from 120 to 180 amp.

to keep it moving; in an occasional oven the amperage required to start the charge amounted to from 300 to 350, with 200 to 300 amp. required to keep it moving. Very few of the charges stuck, so that it was impossible to push the charge out before the circuit breaker acted; as high as 550 amp. was noted in one or two of these cases. One charge in particular, oven No. 49, on

TABLE I—COAL ANALYSIS AND HEATING VALUE

	As Charged	Dry Basis
Moisture.....	8.07%	3.70%
Volatile matter.....	34.66%	37.70%
Fixed carbon.....	48.38%	52.63%
Ash.....	8.89%	9.67%
Sulphur.....	1.04%	1.13%
Hydrogen.....	5.32%	4.81%
Carbon.....	67.51%	73.44%
Nitrogen.....	1.49%	1.62%
Oxygen.....	15.75%	9.33%
Sulphur in fixed carbon from volatile determination....	0.51%	0.55%
Heating Value:		
Calories.....	6,677	7,263
British thermal units.....	12,019	13,073

TABLE II—COAL USED AND OVEN OPERATION

Coal Used, in Tons:	
As charged.....	7,688.3
Dry.....	7,067.2
Ovens Charged.....	603
Coal per Oven, in Tons:	
As charged.....	12.75
Dry.....	11.72
Coking Time, in Hours and Minutes:	
Average gross.....	19:33
Average net.....	19:11

Sept. 29, gave a great deal of trouble; three attempts were made to push the charge before it was possible to clear the oven. However, in no case was it necessary to rake or dig the coke from the ovens.

#### HIGH TEMPERATURE MEASUREMENTS

High temperature measurements were made continuously for several days during the test period in order to give an accurate idea of the operating conditions of the battery. Records were taken of the temperature in the oven walls, regenerators, waste-heat flue, in the coal

mass and in the vapor above the coal. Measurement of high temperatures in a by-product coke oven is attended with great difficulty because of the inaccessibility of certain points where temperature measurements are desirable and because of the limited variety and high cost of apparatus which can be used for these purposes. The results obtained are sufficient, however, to give an accurate idea of the range and average temperature maintained at the important points in the heating system.

A complete survey of temperature conditions through the entire battery was, of course, impossible; but rep-

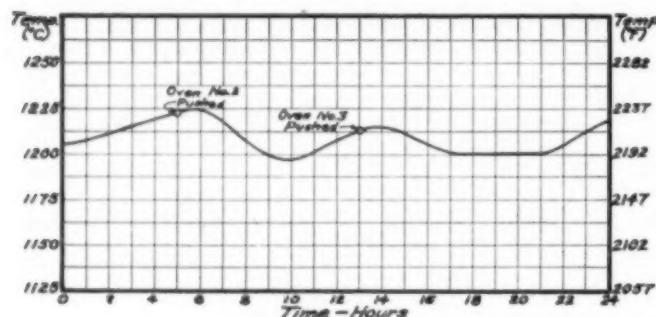


FIG. 3. AVERAGE TEMPERATURE OF HEATING WALL. Showing effect of charging and pushing temperature recorded 7 ft. below top of battery between ovens No. 2 and No. 3

representative points were chosen and the results given in Figs. 3 to 6 inclusive are typical of all operations. During the period of the test certain optical pyrometer measurements were made by the company engineers which confirmed the fact that the locations chosen for our regular measurements were typical.

The general trend of heating wall temperatures, before, during and after charging the adjoining ovens, is given in Fig. 3. These temperatures, of course, are not as high as prevail in certain parts of the wall refractory, for example at the lower regulating brick near the air port, where the maximum temperature is reached. To show the effect of gas and air reversal on the temperature in the heating wall, the curve of Fig. 4 is given.

Temperature measurements were made at three places in four consecutive charges of coal in oven No. 3. Readings were taken with couples 10 ft. long, introduced through charging lids as nearly as possible midway between the oven walls. The mean of the temperature-time curves for these locations is plotted in Fig. 5. Short thermocouples were introduced through the charging lid nearest the pushing end of oven No. 3 to measure the vapor above the coal. Four curves for four consecutive charges are shown in Fig. 6.

Over the checker-brick in the right half of the regenerator under oven No. 3 at the coke and 54 in. in from the face of the regenerator wall the temperature averaged 1140 deg. C. The variation in temperature during reversal of direction of gas burning was about 55 deg. C. at this point. Temperature measurements taken at the junction of the waste heat tunnels from the two batteries averaged 272 deg. C.

#### COKE HANDLING

During the test, two different systems of screening were used as follows:

**Screening System No. 1**—The coke was delivered by the conveyor over an inclined-bar-grizzly screen in the first station. The screen was about 5½ ft. long, 4 ft.

wide and consisted of 1½-in. bars spaced from 1½ to 1½ in. The oversize was delivered in the railroad cars and weighed as "furnace coke." The undersize delivered on a second belt conveyor was carried to a second screening station, where it passed through an inclined-rotary-cylindrical screen, the first half of which consisted of ¾-in. square perforations, and the second half 1½-in. square perforations. The material passing through the ¾-in. perforations was re-screened on a ½-in. shaker screen to separate the breeze and pea size coke. The material passing through the 1½-in. perforations was called nut coke, and that passing over the 1½-in. perforations was classified as stove coke. The breeze, pea, nut and stove sizes were separately loaded in railroad cars and weighed before shipment or storage. Nut and stove sizes, as delivered from their respective bins, passed over shaker feeders before going into the railroad cars. The pea and breeze sizes were thus very completely eliminated from these two domestic sizes.

Since the separation of "furnace coke" by the inclined-bar-grizzly in the first screening station was not considered satisfactory because the screen was not large enough to handle the quantity of coke passing over it and make a good separation, a change was made after three days of the test to the second system, which was as follows:

**Screening System No. 2**—The inclined-bar-grizzly in the first screening station was discarded and replaced by a 2½-in. rotary grizzly, the oversize of which was delivered directly into railroad cars as "foundry" or "large furnace" coke. The coke passing through the first rotary grizzly was carried to the second screening station, where it passed over a second rotary grizzly set at 1½ in. The oversize of this second grizzly was designated as "small furnace" coke. The material passing

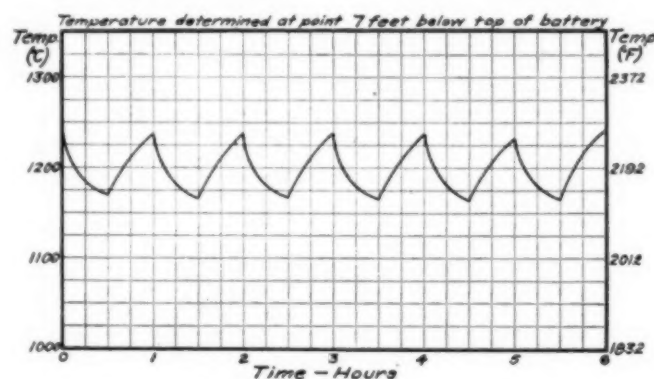


FIG. 4. TYPICAL HEATING WALL TEMPERATURE. SHOWING EFFECT OF REVERSALS

through the second grizzly was separated by the rotary cylindrical screen and sized exactly as in the first system. The furnace coke from the first system and both sizes of furnace coke from the second system, after being weighed, were stacked in a pile at the plant during the test period, so that they were subsequently available for a blast-furnace test as described later. The stove, nut and pea sizes were sold for domestic fuel, as is customary from this plant. The breeze produced was used as boiler fuel at the plant, following the regular practice.

#### COKE YIELDS

Table III shows the different results obtained from the two screening methods. The results for the entire period are summarized together in Table IV.



It is to be noted that 82.7 per cent of the dry coke produced in screening system No. 1 was classified as furnace coke, oversize of the 1½- to 1½-in. inclined-bar grizzly. As explained under description of screening system No. 1, the separation of the furnace coke by the inclined-bar grizzly was not considered satisfactory, as the screen was not large enough to make a good

TABLE III—RESULTS WITH TWO SCREENING SYSTEMS

	Screening System No. 1, Per Cent	Screening System No. 2, Per Cent
Furnace Sizes:		
Large.....		18.3
Small.....		22.0
Total.....	82.7	40.3
Domestic Sizes:		
Stove.....	6.7	34.8
Nut.....	5.2	15.0
Pea.....	0.9	2.4
Total.....	12.8	52.2
Breeze.....	4.5	7.5
Total.....	100.0	100.0

TABLE IV—COKE YIELDS

Coke Produced (Dry):	Tons
Furnace.....	2,704.4
Stove.....	1,178.1
Nut.....	549.5
Pea.....	89.9
Breeze.....	308.4
Total.....	4,830.3
Ratio of Dry Coke to Dry Coal:	Per Cent
Furnace.....	38.3
Stove.....	16.7
Nut.....	7.7
Pea.....	1.3
Breeze.....	4.4
Total.....	68.4
Sizes of Coke Produced:	Per Cent
Furnace.....	56.0
Stove.....	24.4
Nut.....	11.4
Pea.....	1.8
Breeze.....	6.4
Total.....	100.0

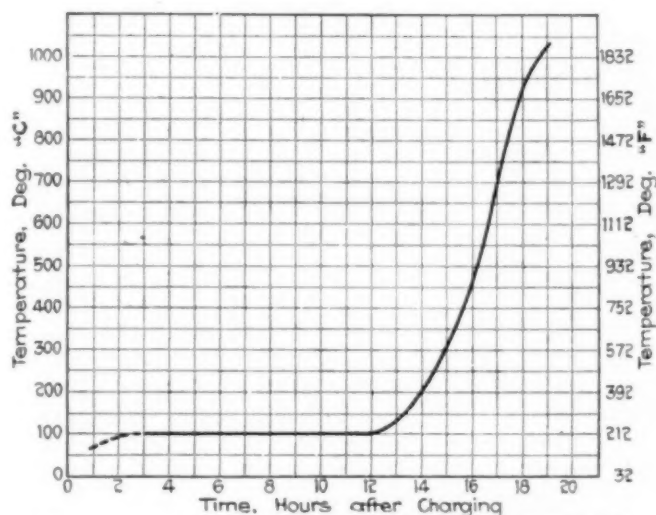


FIG. 5. AVERAGE OF COAL TEMPERATURE CURVES

separation; the very high percentage obtained for furnace size is, therefore, not representative. The total dry furnace coke was only 40.3 per cent of the total dry coke screened during that part of the test when screening system No. 2 was used. However, it should be noted that the yield of stove size is very large, 34.8 per cent of the total coke as screened; there is no doubt that a large amount of the stove size would have been

included in the furnace size if it had been possible to install a 1½-in. inclined-grizzly-bar screen large enough to handle the coke produced and make a good separation.

The small percentage of large-size coke obtained together with the large percentage of the smaller domestic sizes indicated that it would not stand handling and screening without breaking up into smaller pieces, due to the finery and brittle characteristics of the coke.

#### APPEARANCE OF HOT COKE

The hot coke as pushed from the ovens was observed in order to know the temperature and general performance of each oven and each lot was again observed after

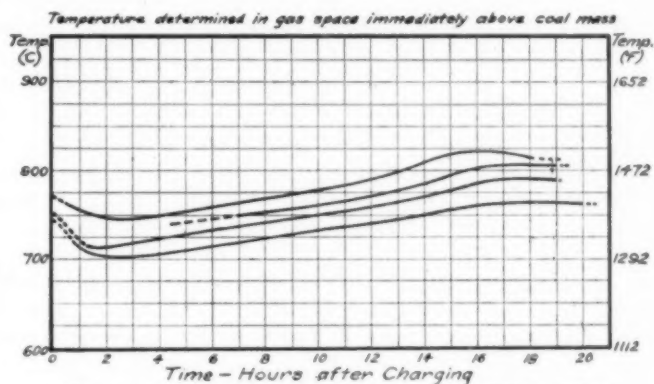


FIG. 6. TEMPERATURE OF VAPOR ABOVE COAL

quenching and dumping on the wharf. By these observations a very complete idea of battery performance was obtained. These observations may be summarized as follows:

The top of the coke mass was, as usual, colder than the rest of the charge. In fact this condition was somewhat exaggerated during the test, as it was impracticable to adjust the battery for the best use of the leaner gas from the Illinois coal when this was to be used for so short a period. From the level of the horizontal flue in the heating wall down to the bottom of the oven the coal was usually thoroughly coked; and in general the heats were uniform for the entire length of the charge. From a number of the charges some uncoked material remained in the center of the charge at the level of the horizontal flue.

From most of the charges a large amount of smoke and flame arose as the coke was pushed from the oven; this was especially noticeable in cases where uncoked material remained at the level of the horizontal flue. The overhang of the coke as it fell from the coke guide into the quenching car was irregular; on the coke side it ranged from 12 to 24 in., while on the pusher side the coke frequently showed signs of crumbling. Immediately ahead of the pusher ram the charge generally crumbled, thus causing a great deal of fine coke. A distinct line of cleavage was noted through the center of the charge in almost all cases.

#### APPEARANCE OF COKE ON WHARF AND IN CARS

The coke on the wharf was very irregular in size, but on the average the pieces were distinctly smaller than for the average by-product coke mixtures. There was no tendency to blockiness and very few pieces were as large as 6 in. in each dimension. The material was decidedly lighter than the average by-product oven coke, weighing only about 23 lb. per cu.ft. The color varied somewhat, but in general the furnace-size was of a dark silver color.

The coke had a decided longitudinal fracture and many of the pieces before reaching the wharf were broken up into fingers. Even the larger pieces showed a tendency to fingering, and by completion of the decided longitudinal fracture generally these broke up into several smaller pieces before reaching the cars. There was no apparent cross-fracture, but the brittleness of the long fingers was such that these frequently broke up into two shorter pieces during handling.

In the railroad cars the furnace size from screening system No. 1, in which a 1½-in. inclined-bar-grizzly screen was used, consisted mainly of small fingers from 1 by 2½ in. up to a maximum of about 2 by 6 in. There were very few blocky pieces about 2½ by 3½ in. The oversize of the 2½-in. rotary grizzly, used in screening system No. 2, in the cars was about half fingery and half blocky coke, averaging much larger than from screening system No. 1. The small-furnace size from this second system, through the 2½-in. but over the 1½-in. rotary grizzly, averaged about 2 by 2½ in. The great difference in size between the coke on the wharf and after loading in the cars shows the decided tendency to breakage during handling.

The cells of the coke were small and regular and in general of a structure indicating suitable characteristics for furnace use. There was no sponge formed, but there was a decided tendency to form a pebbly seam at a distance of 2 to 6 in. from and, in general, parallel to the oven wall. This seam appeared only in a part of the pieces in which it formed an incipient cross-fracture. In general there were no pebbly seams in the coke at the bottom of the oven. The small amount of pebbly mass noted seemed to come from the top and center of the oven in the form of small loosely-cemented lumps of material which were readily crumbled in the hands. Although the coal contained considerable "mother of coal," there was very little evidence of "foreign matter" in the coke, probably because of the fineness to which the coal was crushed.

#### COKE ANALYSES AND TESTS

Each size of coke was carefully sampled for analysis and for determination of moisture content in order to correct to true weight at the time it was loaded in the railroad cars.

The results of proximate and ultimate analysis and heating value determination of the composite sample of each size of coke are given in Table V.

TABLE V—COKE ANALYSIS AND HEATING VALUE

	—Furnace Coke—		—Domestic Coke—		—Coke Breeze—	
	As Loaded	Dry	As Loaded	Dry	As Loaded	Dry
Moisture.....	7.15%	.....	11.51%	.....	17.07%	.....
Volatile matter....	2.18%	2.35%	2.81%	3.18%	4.06%	4.90%
Fixed carbon.....	77.93%	83.93%	73.15%	82.66%	64.69%	78.00%
Ash.....	12.74%	13.72%	12.53%	14.16%	14.18%	17.10%
Sulphur.....	0.85%	0.92%	0.82%	0.93%	0.87%	1.05%
Carbon.....	77.81%	83.80%	73.47%	83.03%	65.68%	79.20%
Hydrogen.....	1.17%	0.41%	1.67%	0.44%	2.54%	0.77%
Oxygen.....	6.55%	0.20%	10.60%	0.41%	15.83%	0.79%
Nitrogen.....	0.88%	0.95%	0.91%	1.03%	0.90%	1.09%
Phosphorus.....	0.009%	0.010%	0.010%	0.011%	.....	.....
Heating Value:						
Calories.....	6,385	6,877	6,049	6,836	5,453	6,576
British Thermal Units.....	11,493	12,379	10,888	12,305	9,815	11,837

The weight per cu.ft. of furnace coke was determined on one car of large furnace coke and also on one car of small furnace coke. This was done by leveling the cars and making the calculations from the net weights of coke and the rated cu.ft. capacity of the cars.

Apparent specific gravity determinations were made on three composite samples of furnace-size coke and an average of these is given as representing the entire lot. A single composite was made up for the entire lot and the true specific gravity determined. The porosity of the coke was calculated from these results for apparent and true specific gravity. These physical properties of the furnace coke may be summarized as in Table VI.

TABLE VI—CHARACTERISTICS OF FURNACE COKE

Weight per Cubic Foot of Dry Coke:	
Furnace size from screening system No. 1.....	23.4 lb.
Large furnace size from screening system No. 2.....	22.8 lb.
Apparent specific gravity.....	0.88
True specific gravity.....	1.85
Porosity.....	52.4%

#### BLAST-FURNACE TEST

In order to test the behavior of the furnace-size coke produced from the Orient coal, arrangements were made to use about 1800 tons of this material in the blast-furnace plant of the Mississippi Valley Iron Co. The coke regularly used at that furnace is produced in Koppers ovens of the Laclede Gas Light Co., St. Louis, from a mixture of Elkhorn, Pocahontas (low volatile) and Illinois coals. The substitution of the Illinois coke for the regular supply was accomplished abruptly and continued without interruption throughout the ten-day period. Several experts were present during this test, and it was the unanimous opinion of these persons and of the blast-furnace operators that the Illinois coke had shown highly satisfactory results. However, it should be borne in mind that the furnace used for this test was of small capacity, and it is not certain, therefore, that the results in this case would be duplicated on a large-size furnace.

#### SPECIAL OVEN TESTS

In order to study the effect of lower temperature and longer time of coking, and to get some idea of the value of certain special coal mixtures, a few ovens were operated under different conditions than normal. The lower temperature trials were made in oven No. 1 during the period of the test by cutting down the quantity of gas burned in the heating walls of this oven. The special mixtures were made up at the end of the test period and tried out in one or more ovens.

*Low Temperature Coking of Orient Coal.*—Oven No. 1 was changed from its regular operating period beginning Oct. 1 and three charges of distinctly longer periods, 22½, 23½ and 25½ hr., were pushed on Oct. 3, 4 and 5 respectively. The temperature of this oven was from 50 to 100 deg. C. lower than the temperature of the remaining ovens in the battery. The coke from these special tests was very similar to that obtained from the same coal coked for the usual 19-hr. period in that the cell structure was not materially different and that there was the usual small amount of "foreign matter" and no sponge. However, the material as it lay on the wharf appeared decidedly larger and blockier and there was slightly less of the pebbly mass or pebbly seam. The blocks of coke were decidedly stronger, judged both by their action when handled and by the shatter test described below. The results of this special work at lower temperatures were very closely comparable with the results obtained at Dover, Ohio, when using the same coal in a narrower oven and coking at a corresponding rate, measured in inches of coke formed



per hour. It is evident from these tests that stronger, larger coke will be obtained at the somewhat lower temperatures used in this work than at the temperature at which it was necessary to operate during the full test at St. Paul in order that the gas supply of the city would not be interrupted.

**Mixture of Orient and Pittsburgh Coals.**—In order to study the character of coke produced from a mixture of equal parts of Pittsburgh and Orient coals, a single oven was charged with this mixture. Oven No. 60 was charged 5:30 p.m. Oct. 7 and pushed 11:30 a.m. Oct. 8; the charge was 25,100 lb. The coke from this 18-hr. test was thoroughly coked, but the appearance on the wharf was not encouraging. There was decided longitudinal fracture, indicating the finery tendency common to high volatile coals, but the coke was fairly tough. The cell structure resembled that of Orient coal alone, except in the upper central section of the oven, where considerable sponge was formed. There was no noticeable cross-fracture, but the irregular shapes showed that the breakage of the material in regular handling would probably be rather high. The pebbly seam so frequently noted in coke from 100 per cent Orient coal was not apparent in this single test; but the tendency of Pittsburgh coal to produce sponge was not counteracted by the mixture.

**Mixture of Orient and Pocahontas Coals.**—A mixture of 25 per cent Pocahontas and 75 per cent Orient coal was used in three ovens charged on Oct. 7 and pushed after approximately 17 hr. of coking. In each case the charge was about 25,200 lb. The coke produced under these conditions was blocky and on the average of large size, but the pieces were very irregular. There was no tendency to finger, but a decided cross-fracture was shown. The coke, although appearing soft, was unusually tough, as will be evident from the high percentage unbroken in the shatter test. The cell structure was irregular and the general appearance of the material on the wharf would have indicated under-coking, but the appearance while hot, as it was pushed from the oven, showed that this was not the fact. The very small percentage of fine material indicated that an unusually high percentage of furnace-size would be available from this mixture.

**Shatter Test of Special Cokes.**—In order to get a rough check on the relative strength of the different special cokes which were made, a shatter test was carried out on each of the samples. For this test a 50-lb. sample of large pieces of coke taken from the belt, none of which pieces would begin to pass through a 2-in. square mesh screen, was dropped four times from a height of 6 ft. onto an iron plate. The pieces of coke which following this test would not in any position pass through the 2-in. screen were weighed and their ratio to the weight of the original sample was taken as the "percentage unbroken" in results indicated below.

The usual foundry mixture, consisting of 30 per cent Pocahontas, 35 per cent Pittsburgh and 35 per cent Elkhorn coal, was found to give a result of 68 per cent unbroken by this test. The straight Orient coal coked for 19 hr. gave a coke of which only about 27 per cent remained unbroken by this test. The coke obtained from 22- to 26-hr. coking periods was somewhat stronger, ranging from 27 to 38 per cent unbroken. The mixture of 50 per cent Orient and 50 per cent Pittsburgh showed about 53 per cent unbroken, and the

mixture of 25 per cent Pocahontas with 75 per cent Orient was strongest of all, with 74 per cent unbroken.

The above results are merely an indication and must not be taken as any accurate measure of the strength, since only a limited number of tests were made. Large irregularities are always found in this kind of testing and moreover this test is not strictly significant as to the strength of the material, since at the best it really gives an accurate measure only of the likelihood of breakage during handling.

#### BY-PRODUCTS AND GAS PRODUCED

The results obtained during six days from 8 a.m., Sept. 29, 1918, to the same hour Oct. 5, 1918, were used as the basis for by-product and gas results, since during this period only Orient coal was in use and the system contained only products from this coal. During this period 6092.3 tons of natural coal were charged to the ovens, equivalent to 5600.6 tons on the dry basis, and these figures are used in calculating the yield of tar, ammonium sulphate, light oil and its products, and gas, which are reported in the following sections.

#### TAR AND AMMONIA

During the test, daily inventory was taken of the quantity of the tar and liquor in stock, accurate weights and specific gravities of tar shipments were recorded, and other necessary arrangements made to permit accurate determination of the quantities of these materials produced.

It was the intention during the test to produce only ammonium sulphate and maintain the minimum practicable supply of ammonia liquor. However, a slight variation in the quantity of liquor at the beginning and end of the test inevitably resulted, and appropriate correction for this difference in inventory was made and appears in the record of results reported. Samples of the tar, liquor and sulphate were taken for analysis regularly, so that the quality as well as the quantity of these materials would be a matter of record.

TABLE VII—YIELD AND CHARACTERISTICS OF TAR

Tar produced, as measured, gal. ....	47,560
Tar produced, dry (computed), gal. ....	46,100
Tar, as produced, per ton of coal as charged, gal. ....	7.81
Tar, dry, per ton of dry coal, gal. ....	8.23
Water in tar, by weight, per cent. ....	2.6
Specific gravity, as produced. ....	1.187
Specific gravity, dry basis (computed) ....	1.192

TABLE VIII—YIELD OF AMMONIUM SULPHATE

Produced, scale weight, lb. ....	155,510
Produced, pure, lb. ....	151,100
Equivalent in liquor, start of test, pure, lb. ....	15,920
Equivalent in liquor, end of test, pure, lb. ....	34,700
Equivalent due to liquor increase, pure, lb. ....	18,780
Total production, pure, lb. ....	169,880
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> per ton of coal as charged, lb. ....	27.88
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> per ton of dry coal, lb. ....	30.33
NH <sub>3</sub> per ton of coal as charged, lb. ....	7.19
NH <sub>3</sub> per ton of dry coal, lb. ....	7.82
Average of NH <sub>3</sub> in ammonium sulphate produced, per cent. ....	25.06

The sulphate delivered from the saturators into wheelbarrows was weighed as it was conveyed from the saturator room to the storage pile. The weight of sulphate produced daily varied largely in accordance with the amount of ammonia liquor accumulated or worked up into the sulphate during the day. From the measurement of volume, the temperature, specific gravity, and per cent of NH<sub>3</sub> by weight, as determined in the laboratory test, the pounds of NH<sub>3</sub> and the equivalent weight of (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> were computed for the initial and final inventories.

## LIGHT OIL

The rich and lean gas produced at this plant are separately scrubbed for light oil recovery, but the light oil separated from the wash oil in the stripping stills is collected together. During the test period two sections of the light oil "running tank" were used on alternate days in order to permit careful measurement of each day's light oil production.

Table IX gives the total production of light oil for the six-day by-product period and the yield based on the analysis of the composite sample analyzed according to methods prescribed in Ordnance Publication No. 1800.

TABLE IX—LIGHT OIL YIELD AND ANALYSIS

Producers, gal.	22,570
Composition:	Per Cent.
Boiling under 200 Deg. C. (Engler Flask)	84.4
Washing loss	5.7
Steam distillation residue	5.5
Benzene (Laclede still)	56.8
Toluene (Laclede still)	13.4
Solvent Naphtha (Laclede still)	3.5
Residue	15.1
Produced per Ton of Coal:	Gal.
As charged	3.71
Dry	4.03
Produced per Ton of Coal:	Gal.
(Per Cent under 200 Deg. C.)	
As charged	3.13
Dry	3.40
Benzene per Ton of Coal:	Gal.
As charged	2.11
Dry	2.29
Toluene per Ton of Coal:	Gal.
As charged	0.497
Dry	0.540
Solvent Naphtha per Ton of Coal:	Gal.
As charged	0.130
Dry	0.141

TABLE X—GAS ANALYSIS

	Rich Gas, Per Cent	Lean Gas, Per Cent
CO <sub>2</sub>	4.5	3.8
Illuminants	4.4	2.4
O <sub>2</sub>	0.6	0.4
CO	11.0	12.4
CH <sub>4</sub>	31.5	25.1
H <sub>2</sub>	42.4	50.7
N <sub>2</sub>	5.6	5.2
Sp.gr. (Air = 1)	0.476	0.437
H <sub>2</sub> S (grains per 100 cu.ft.)	430	340

TABLE XI—GAS PRODUCTION

Coal Used:	Tons
As charged	6,092.3
Dry	5,600.6
Volume of Gas Produced:	M.Cu.Ft.
Surplus—Rich to City	31,982
Lean to boilers	1,440
Total surplus	33,422
To Ovens—Battery A	2,842
Battery B	29,015
Total to ovens	31,857
Total gas made	65,279
Gas per Ton as Charged:	Cu.Ft.
Surplus	5,490
To ovens	5,230
Total	10,720
Gas per Ton of Dry Coal:	
Surplus	5,970
To ovens	5,690
Total	11,660
Gas to Ovens (per cent of total)	48.8
Heating Value of Gas:	B.t.u. per Cu.Ft.
Rich	569
Lean	490
Heat in Gas per Pound of Coal as Charged:	B.t.u.
In surplus gas	1,550
In gas to ovens	1,280
Total	2,830
Heat in Gas per Pound of Dry Coal:	B.t.u.
In surplus gas	1,690
In gas to ovens	1,390
Total	3,080
Heat in Gas Used to Coke Coal, Per Cent	45.2

## GAS

The gas produced at the plant was separated at the ovens into rich and lean, the quantity of rich gas being so regulated as just to supply the requirements for

the St. Paul Gas Light Co., to which all of this gas is sold. The lean gas remaining was used for heating the battery, and, if there was any excess, for firing the boilers.

The average analysis and total production of gas for the six-day by-product test period, together with the yield per ton of coal and relative heating value calculations, are presented in Tables X and XI.

## SUMMARY

As a result of the test it is clearly demonstrated that some of the Illinois coals can be coked in the "chamber-type" oven without radical change in operating methods for the production of coke which can be successfully used in a blast-furnace. However, it appears that the temperature at which Illinois coal should be handled for the production of the best coke is somewhat lower than the best operating temperatures for Eastern coals and moreover the speed of coking of the Illinois coal is somewhat less. The yield of gas and by-products from Illinois coal of the kind tested is excellent both in quantity and quality. Of course the coal tested in this case represents one of the best Illinois coals for coking purposes, being lower in ash and sulphur and otherwise superior to many from this field.

In general, the comparison of Eastern coking coals with those from the Mid-Continent field must be made upon an economic basis, since which source will be preferable depends altogether on local conditions which will affect the cost of the material and the relative expense of handling. These phases of the question have, however, not been discussed in this report.

## ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance and co-operation of the engineers and chemists who were associated with them in this work, as well as that of Mr. T. G. Janney, manager, and Mr. K. G. Richards, superintendent, of the plant, and Mr. F. W. Sperr, Jr., chief chemist of the Koppers Co., all of whom did all in their power to make the work both pleasant and successful. Special acknowledgement is also made of the great assistance which Mr. I. V. Brumbaugh has given us in working up the data contained herein and in preparing this manuscript.

Washington, D. C.

## A. I. M. E. to Have Large Program at Chicago Meeting

From a technical point of view, the Chicago meeting of the Institute, Sept. 22 to 26, promises to be one of the most interesting in its history. The wealth of material in the line of technical papers for discussion is greater than has been offered for any previous meeting; upward of 150 papers have been submitted to the committee, who find it no small task to arrange a program to present this number with a minimum of conflicts among papers on allied subjects.

One of the excursions to be made by the Institute as a body during this meeting is to the LaSalle district. A special train in leaving Chicago early Thursday morning will take the members and guests to LaSalle, Ill., where automobiles will convey the different parties to the coal mines, cement works and zinc smelters. For the ladies, and others of the party not particularly interested in these industrial operations, the LaSalle hosts plan an automobile trip to Starved Rock.



## The Economic Status of American Chemical Industry

BY FREDERICK E. BREITHUT

Major, Chemical Warfare Service, U. S. Army

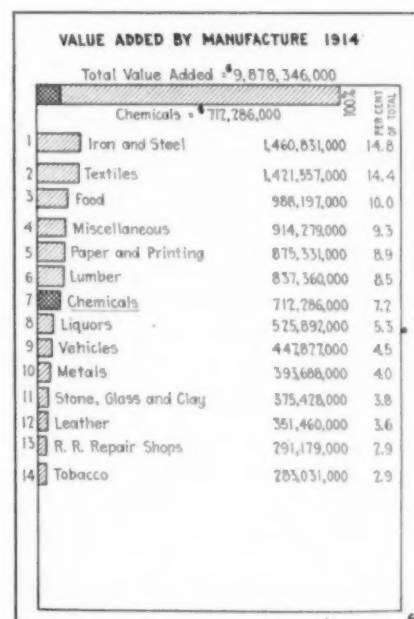
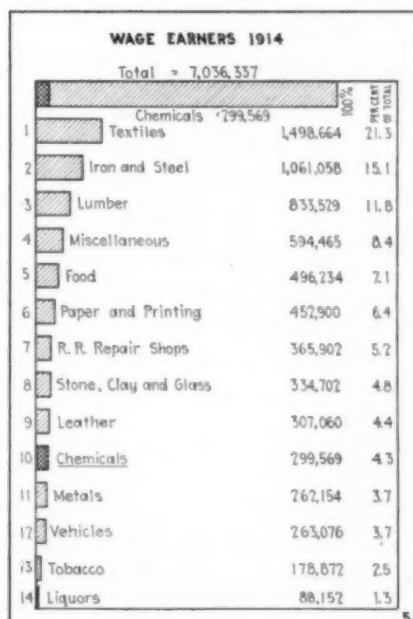
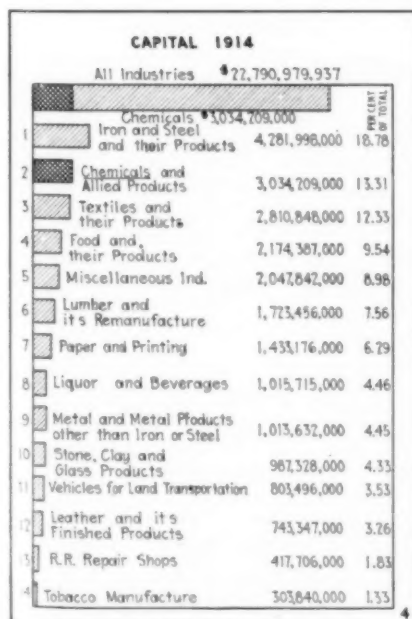
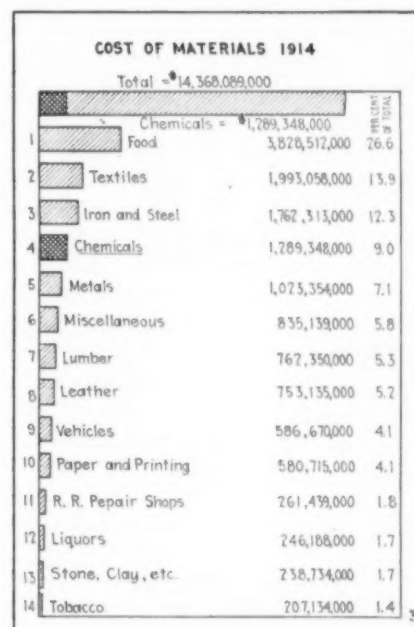
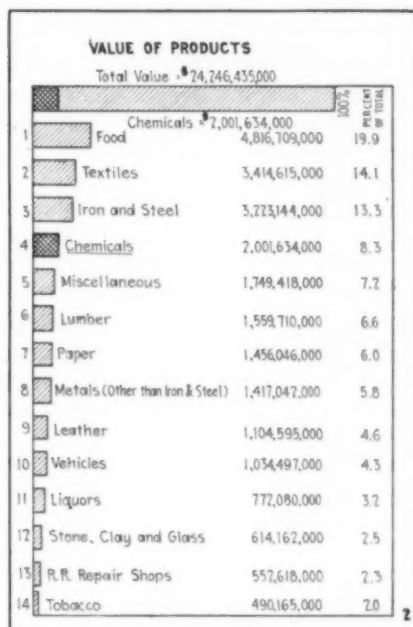
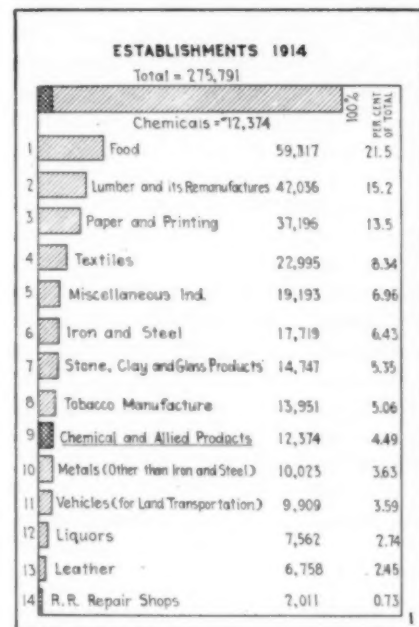
THE accompanying charts are based on the statistics given in the Census of Manufactures for 1914. They try to give some idea of the relation of chemical industry to the total of industry of the country.

In endeavoring to present a picture of chemical industry as a whole one is immediately confronted with the difficulties of classification. The Census of Manufactures for 1914<sup>1</sup>, for example, considers the group "chemical and allied products" as including "not only the industries whose products are chemicals in the ordinary sense of that term, but also the industries which employ to a large extent chemical processes in manufacture." In the introduction to the consideration of this group it is remarked: "The group is a very compli-

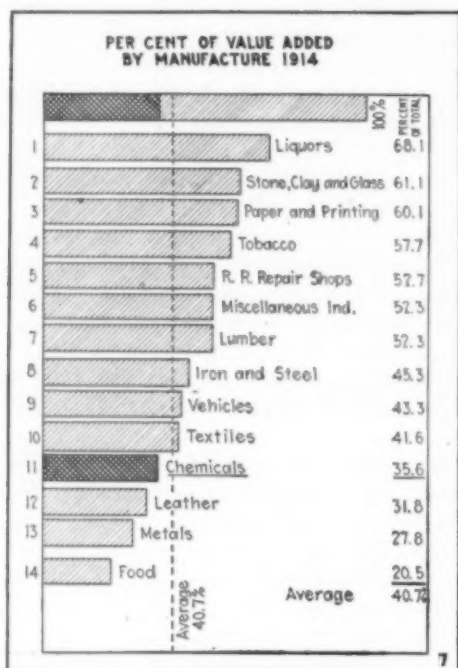
cated one and the various products differ most widely in the character and in the use to which they are put. There is considerable duplication in the combined value of products for the group, due to the use of the products of certain industries as materials for others."

The Census of Manufactures for 1914 divides all manufactures into fourteen general groups as follows: (1) Food and kindred products, (2) textiles, (3) iron, steel and their products, (4) lumber and its remanufacture, (5) leather and its finished products, (6) paper and printing, (7) liquor and beverages, (8) chemicals and allied products, (9) stone, clay and glass, (10) metal and metal products other than iron and steel, (11) tobacco manufactures, (12) vehicles for land transportation, (13) railroad repair shops, (14) miscellaneous industries.

The group "chemicals and allied products" is subdivided in turn into twenty-four sub-groups, as follows: (1) baking powders and yeast, (2) blacking stains and dressings, (3) bluing, (4) bone, carbon and lampblack, (5) candles, (6) chemicals and acids, (7) cleansing and polishing preparations, (8) coke, not including gas-



<sup>1</sup>Abstract of the Census of Manufactures, 1914. CHEMICAL & METALLURGICAL ENGINEERING, Vol. 19, 6a, pp. 371-386.



house coke, (9) drugs, etc., (10) dyestuffs and extracts, (11) explosives, (12) fertilizers, (13) gas, illuminating and heating, (14) glue, not elsewhere specified, (15) greases, (16) ink, printing, (17) ink, writing, (18) oils, (19) paint and varnish, (20) petroleum, refining, (21) salt, (22) soap, (23) turpentine and rosin, (24) wood distillation, not including turpentine and rosin.

Of these sub-groups, the item "chemicals and acids" is again subdivided into twelve parts, as follows: (1) acids, (2) sodas and sodium compounds, (3) potash and potassium salts, (4) alums, (5) coal-tar products, (6) cyanides, (7) bleaching materials, (8) chemical substances produced by the aid of electricity (including those belonging under other groups), (9) plastics, (10) compressed or liquefied gases, (11) fine chemicals, (12) chemicals not otherwise specified (such as glycerine, cream of tartar, epsom salts, blue vitriol, copperas, etc.).

On the other hand, the monograph entitled "chemicals and allied industries" of the series issued on the

basis of the Census of Manufactures for 1914 includes the twelve subdivisions just enumerated, and in addition fertilizers, paints and varnishes, explosives, dyestuffs and extracts, wood distillation, essential oils, bone, carbon and lampblack. To the busy man seeking information on chemical industry as a whole, or the relationship of a particular part of the industry to the whole chemical industry or to the industry in general, the picture is one of confusion. Under the circumstances it is only natural to find that dissatisfaction has been expressed concerning the present state of our chemical statistics. Thus Bernhard C. Hesse,<sup>3</sup> in 1915, presented a plan for a revision of our chemical statistics which resulted in the appointment of a committee of the American Chemical Society "to devise some practical and practicable way of obtaining such revision and of putting it into useful and serviceable effect." As chairman of this special committee of the American Chemical Society, Dr. Hesse<sup>3</sup> prepared a consolidated list of articles used or produced in or by chemical industries as they appear in the most diversified commercial reports.

Accepting for purposes of comparison the data given in the 1914 Census under the heading "Chemicals and Allied Products" as related to industry as a whole, the charts shown herewith may be regarded as giving a general survey of the economic status of American chemical industry just prior to the outbreak of the world war.

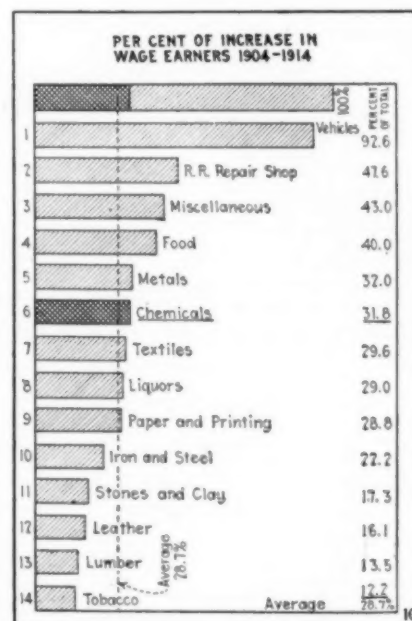
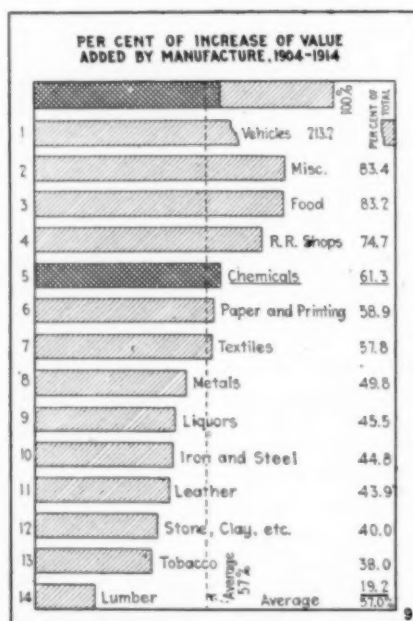
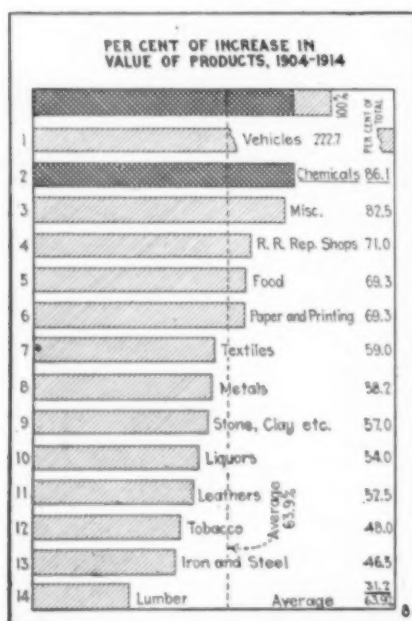
Chart I shows that of the 275,791 manufacturing establishments in the United States in 1914, 12,374 were engaged in chemical manufacture. This constitutes 4.49 per cent of the total establishments and places the group "Chemicals and Allied Products" in the ninth place in the order of number.

Chart II arranges the fourteen groups in the order of their importance from the standpoint of the value of their products. In this respect "Chemicals and Allied Products" ranks fourth, with a value of \$2,001,634,000, constituting 8.3 per cent of the total.

Chart III shows the groups from the standpoint of

<sup>3</sup>Jour. Ind. & Eng. Chem. 7, 58.

<sup>3</sup>Jour. Ind. & Eng. Chem. 8, 749; METALLURGICAL & CHEMICAL ENGINEERING, Vol. XV, No. 3.





cost of materials entering into the industry, and in this respect "Chemicals and Allied Products" ranks fourth, with a value of \$1,289,348,000, constituting 9.0 per cent of the total.

Chart IV arranges the groups in the order of their importance from the standpoint of capital invested. In this regard "Chemicals and Allied Products" ranks second, with a total capital investment of \$3,034,209,000, constituting 13.31 per cent of the total.

Chart V arranges the groups in the order of their importance from the standpoint of the number of wage earners. In this regard "Chemicals and Allied Products" ranks tenth, employing 299,569 workers, which constitutes 4.3 per cent of the total.

Chart VI arranges the groups in the order of their magnitude from the standpoint of the value added by manufacture. In this regard "Chemicals and Allied Products" ranks seventh, the value added by manufacture totaling \$712,286,000, constituting 7.2 per cent of the total.

Chart VII shows the per cent of value added by manufacture for each of the fourteen groups. In this regard "Chemicals and Allied Products" ranks eleventh, with 35.6 per cent. (The average per cent of value added by manufacture for all industries is 40.7 per cent.)

Having shown the picture of the status quo of industry as a whole and of its large groups as it existed in 1914, an attempt was made to get an idea of the growth of these industries for the period 1904-1914. The results are shown in Charts VIII, IX and X.

Chart VIII shows the per cent of increase in value of products in the period 1904-1914. In this regard "Chemicals and Allied Products" ranks second, being exceeded only by "Vehicles," which includes automobiles. The per cent of increase in value of products is 86.1, which is much above the average for all industry (63.9 per cent).

Chart IX shows the per cent of increase of value added by manufacture in the period 1904-1914. "Chemicals and Allied Products" ranks fifth. The per cent of increase for chemicals, etc., in this respect is 61.3, which is a little above the average for all industry (57.0 per cent).

Chart X shows the per cent of increase in number of wage earners in the period 1904-1914. In this respect

TABLE I. APPROXIMATE VOLUME OF BUSINESS IN 1914 AS COMPARED WITH 1917

Class	1914	1917
1. Coal tar crudes, intermediates, dyes.....	\$25,000,000	\$70,000,000
2. Drugs and pharmaceuticals.....	68,000,000	150,000,000
3. Essential oils, flavoring and perfumery materials.....	3,000,000	10,000,000
4. Explosives.....	41,000,000	500,000,000
5. Fertilisers.....	203,000,000	258,000,000
6. Heavy chemicals.....	39,000,000	177,000,000
7. Mineral acids.....	26,000,000	100,000,000
8. Miscellaneous inorganic chemicals.....	55,000,000	100,000,000
9. Miscellaneous organic chemicals.....	115,000,000	215,000,000
10. Natural dyestuffs and tanning materials.....	30,000,000	56,000,000
11. Paints and varnishes.....	149,000,000	175,000,000
12. Proprietary preparations.....	105,000,000	200,000,000
13. Soaps and glycerine.....	136,000,000	232,000,000
14. Wood distillation products and naval stores....	35,000,000	76,000,000

"Chemicals" ranks sixth, with an increase of 31.8 per cent, whereas the average increase was 28.0 per cent.

The remarkable growth of American chemical industry under the stress of war has been the subject of much

"The statistics of capital have been frequently referred to in the reports of previous censuses as defective, and in fact almost worthless, and it has been repeatedly recommended by the Census authorities that the inquiry should be omitted from the schedule. Experience at the census of 1914 confirms the belief that the statistics are of little value."—*Abstract of the Census of Manufactures, 1914*, p. 11.

comment. An attempt to gage how great this growth has really been may be interesting. To this end the usual sources of information were consulted—trade journals, the files of the governmental bureaus in Washington, the manufacturers themselves. Table I shows the 1914 and 1917 figures for the more important chemicals.

## The Explosion of Chemicals—II\* Workmen's Compensation Acts

BY CHESLA C. SHERLOCK

IN our discussion of the liability of an employer to injured employees under the common law, we found that certain abuses had crept into the common law practice which made it practically impossible for an injured workman to recover damages for his injury. His right of recovery was limited to a very small percentage of the cases arising, and then his recovery depended upon his ability and resources sufficient to overcome his employer in a legal battle before the courts. The common law liability was founded entirely upon the theory of fault. Let the fault for the act be determined, and then the party at fault had the damages assessed against him. Only in a limited sense was this fault ever found to lodge entirely against the employer.

The narrowness of the common law soon gave rise to a spirit of unrest among the laboring classes and also among certain employers who had been forced to pay damages to injured workmen. These employers found that when a workman did recover he generally recovered an excessive damage, because the amount he was entitled to was left entirely to the whims of the jury. So the demand came for a new system of liability which would eliminate legal controversy, definitely fix the employer's liability so that he could anticipate it and guard against financial loss by means of insurance, and at the time guarantee the payment of such damages to injured workman at the time when the damages were most needed.

The theory of the compensation acts is not based upon fault at all, but it is based upon the idea that all injuries suffered by accident in the course of the employment should be compensated. It is said that during his productive years the workman contributes to the wealth of society. Then, when industry contributes to rob him of his earning power by incapacitating him, society or industry should share the loss with him.

### COMPENSATION NOT DAMAGES

Compensation is not in any sense damages. The compensation acts do not attempt to indemnify the workman for the actual loss sustained, but to merely share that loss with him. So we find that the compensation acts usually determine the amount of the loss sustained by the workman by ascertaining his average wages for the year next preceding the date of injury and then dividing that by one-half or two-thirds or whatever percentage the statute has determined the industry should bear and making that proportion the amount the employer shall pay.

The compensation acts go farther and absolutely deprive his employer of his common law defenses, so that it is practically impossible for the employer to delay

\*The first article on this subject, on "Common Law Liability," appeared in CHEM. & MET. ENG., July 15, 1919, Vol. 21, No. 2, p. 83.

or evade payment. They likewise deprive the employee of his common law rights, so that he can recover compensation and nothing more. Injuries that are reasonably common are set out in the act and the workman is allowed a specific number of weeks' compensation, so that he knows and the employer knows at once just the exact amount that is due. In other cases, particularly of temporary disability, the employer is to pay so long as the disability continues.

This is fair and just to both parties concerned. The employer in no case is called upon to pay an excessive judgment, as was formerly the case, and the payments are distributed over a number of weeks so that their payment will not financially embarrass him or throw him into bankruptcy. On the other hand, the workman is sure of getting his award and without the necessity of legal expense or a long protracted fight in the courts. The basis of recovery under the compensation acts is limited to those injuries causing incapacity through an accident arising out of and in the course of the employment.

It is not the purpose here to give an extended exposition of the decisions upon the compensation acts, as such would be impossible in the short space possible for this review of the matter. The question of what is an accident is pretty well settled at this time. The courts are practically united in saying that an accident is an unlooked for and untoward event happening within chance and without design or intention. They have said that under the compensation acts the term shall be given its ordinary and usual meaning and shall not be construed as employed in a technical sense.

#### ACCIDENTS MUST BE IN COURSE OF EMPLOYMENT

There is no doubt that an explosion of chemicals in the ordinary sense would clearly be termed as an accident under the compensation acts. But this is not sufficient to establish the employer's liability. The accident must arise "out of and in the course of the employment." If the workman is regularly engaged in the duties of his employment and is proceeding in a usual and careful manner and an explosion occurs which clearly arises out of the employment of that particular workman, then he would be entitled to compensation.

But if the workman is outside the course of his own employment, even though the accident arose out of the general employment, he is not entitled to compensation. That is to say, if a workman is employed at his own task, but goes over to the bench of a fellow workman and meddles in his work so that an explosion takes place, he is not ordinarily entitled to compensation, because he is outside the course of his employment.

There are numerous decisions upon this point, but I think one will serve to illustrate the trend of the courts. A workman while on his way to a toilet paused at the bench of a fellow workman and commenced to play with some dynamite caps which the other workman used in his work. As a result there was an explosion causing the loss of several fingers and other severe injuries. He was not given compensation because he was outside the course of his employment at the time accident arose.

There are certain other limitations placed upon the employer's liability which it is well to keep in mind.

#### "HORSE PLAY" BARS COMPENSATION

If the workman is injured as the result of "horse play" or practical jokes on the part of other workmen he is not entitled to compensation, as it has been held again

and again that horse play is not within the course of the employment. This is an unfortunate situation because the victim of the prank is nearly always innocent of any wrong doing, yet is made to suffer the burden of his fellow workmen's pranks.

While there is no legal liability imposed upon the employer in such cases, there is certainly a moral obligation imposed upon him to stop such practices as soon as he discovers them among his employees. If the employer goes to the trouble to tell his men just what happens in cases of injury and tell them of specific cases where harmless pranks have resulted in grave disaster, it will generally be sufficient to remove any chance of injury to innocent workmen.

If a workman is guilty of "serious and willful misconduct" and such misconduct is the cause of his injury, he cannot recover compensation. This generally refers to the manner in which he obeys his employer's instructions or the manner in which he does the work he is required to do. It would certainly be willful misconduct for a workman to willfully explode a charge of chemicals, even though he did it in a spirit of fun or experimentation. Unless such an act was clearly within the scope of his employment, he would not be entitled to recover compensation from his employer.

#### ANOTHER'S MALICIOUS INTENTION BARS PAYMENT.

The employer is not liable for the payment of compensation in cases where the workman is injured by the malicious intention of another. If two workmen get into a fight and one is injured through the malice of the other, no liability attaches to the employer. Furthermore, the employer is not liable under the compensation acts for the payment of compensation to casual workers, or those employed at casual work, such as window washers and those who are employed only for odd jobs at irregular intervals.

The employer generally is not liable for the payment of compensation to those who are not engaged in hazardous employment. He is not ordinarily liable to clerks and office help, or any one who falls within the clerical class, unless in the course of their work they are subjected to the hazards of the business.

The only way that the employer can determine his specific obligation under the compensation act is to refer himself to the statute under which he is operating. They vary in details in the respective jurisdictions. However, the main points given above are practically general rules in force wherever the compensation practice is followed, and they are supported by the great weight of judicial authority.

The compensation acts intend to exercise fairness and honesty among all classes and when they are administered in the true spirit they are a distinct improvement over the old common law system.

#### Glass and Glass Sand

In spite of the approach of national prohibition the demand for certain lines of glassware normally used in the dispensing of beverages to be banned has continued. In addition a new demand has arisen in unexpected volume for glassware to be used in the serving of soft drinks. This class of trade is now demanding an even better quality than was commonly sold for bar service. It is expected that soft drinks and near-beers will greatly increase in popularity and this new trade should eventually largely replace that lost in beer and liquor bottles.



## The Nelson Electrolytic Chlorine Cell\*

Development and Description of the Cell—Technology and Special Features: Simplicity of Structure, Graphite Anode, Durability, Floor Space, Attendance, Quality of Chlorine and Caustic and Electrical Efficiency

By C. F. CARRIER, JR.†

SUCH a number and variety of electrolytic chlorine cells have been described in the patent and technical literature, or presented before the scientific societies from time to time, that it is with some diffidence we ask attention to this somewhat threadbare topic. Only some extraordinary feature would entitle a chlorine cell to a place on the program of the American Electrochemical Society.

Most chlorine cells have been introduced to the scientific world in their early patent or experimental stages, and many remarkable devices have been described and efficiencies claimed which for some reason have seldom materialized in practice. The Nelson cell is not a novelty of the hour, nor does it yield any theoretical results which have not been previously claimed for other cells, but surely the most extensively used chlorine cell in the world must possess some features of practical importance that are worthy of careful analysis, and we therefore give publicly for the first time a complete history, description and record of its commercial application. It has been the author's privilege to erect and operate three large plants using this cell, therefore the subject can be treated with intimate practical knowledge as well as with the co-operation of the inventor.

### DEVELOPMENT OF CELL

This cell was developed by Mr. Harry R. Nelson of the Warner Chemical Co., at Carteret, N. J. It was the desire of this company to secure a supply of comparatively pure chlorine gas for use in the manufacture of chlorine chemicals other than bleach. With this aim in view, they began the production of chlorine about 1905 and it might be mentioned in passing that one of the oldest chlorine plants in the United States has been successfully operating for fourteen years on New York harbor with power that was not hydraulically generated.

The first installation consisted of McDonald cells<sup>1</sup>. These are essentially three-compartment cells. Two perforated metal cathode plates support the asbestos diaphragm and divide the cell into a middle anode compartment and two outer, or cathode, compartments. Graphite anode blocks with lead lugs were suspended from an earthenware cover box and the diaphragm was held in place by masses of cement concrete in the bottom and ends of the anode compartment. The cathode compartments were filled with caustic soda solution to about the same level as the brine in the anode compartment. Besides a very low ampere efficiency, this cell gave many operating troubles and the upkeep was excessive.

In 1908 it was determined to investigate the relative merits of mercury cathode and diaphragm cells. Mr.

Nelson worked on the improvement of the diaphragm cell and the author developed a mercury cathode cell. As a result of these tests, it was decided by all concerned that the diaphragm type of cell was better adapted to the needs of the Warner Chemical Co. and further effort was directed to the improvement of the diaphragm cell. The McDonald cells were so materially altered that they completely lost their identity and a new cell was built which was the progenitor of the Nelson cell.

Much of the trouble with the McDonald cell was attributed to the use of concrete in the anode compartment. This was eliminated in the Nelson cell of 1908 by making the perforated metal cathode plate U-shaped and closing the ends of the anode compartment thus formed, by means of slate slabs. This was a great improvement, but the caustic compartment was still filled with caustic liquor and the ampere efficiency was still lower than was desired.

It was soon found that better results were obtained by leaving the caustic compartment empty and allowing the caustic and brine solution to drip from the diaphragm, but there was still some trouble due to decreasing percolation and increasing resistance as the operating period lengthened.

In 1913, these difficulties were overcome by the introduction of steam into the cathode chamber and the cell assumed the final form to be described below. This unique improvement was followed by the discovery of a process for treating the graphite anodes which more than doubled the life of the graphite, and later by the development of an automatic feeding device, details which will be discussed further below under "description" and "special features."

The culminating development has been during the period of the war, there now being in operation over

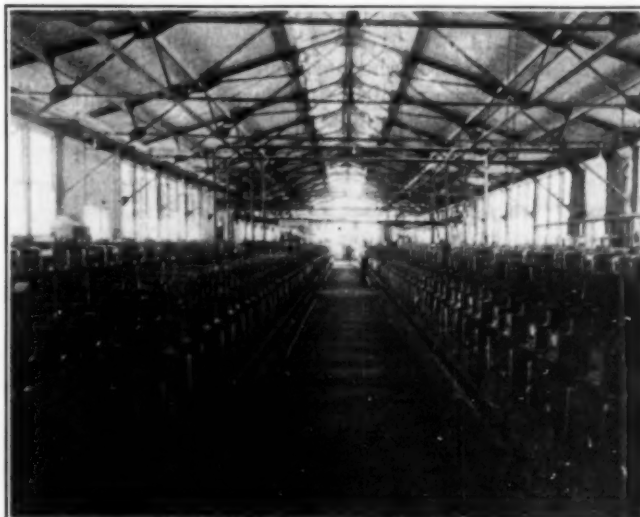


FIG. 1. INSTALLATION OF CHLORINE PLANT

\*Extract of a paper read before the American Electrochemical Society, New York, April 3-5, 1919.

†American Cyanamid Co.

<sup>1</sup>U. S. Pat. 697,157, April 8, 1902.

twenty plants in various parts of the world. Nearly 8000 cells have been installed, rated at 1000 amperes capacity and representing a daily output of about 200 tons of chlorine gas. The largest single chlorine plant in the world is the United States Government plant at Edgewood Arsenal, Baltimore, Md., where over 3500 Nelson cells were installed for the production of 100 tons of chlorine gas per 24 hours. The construction of this plant was one of America's greatest chemical achievements during the war. It was built at a moderate cost, only 7 per cent above the estimates, which had not included overtime; it was ready to operate on the date promised and was completed without alteration of the plans after construction had been started. The other large chlorine plants of the world have been built in sections from time to time over periods of many months, while the Edgewood plant, the largest of them all, was entirely built in four months.<sup>2</sup>

#### DESCRIPTION OF THE CELL

A description of the cell is to be found in U. S. P. 1,149,210 of Aug. 10, 1915, but a much better idea of the general construction can be obtained from the accompanying illustration. Special attention is called to the simplicity of the design. A substantial, rectangular tank made of  $\frac{1}{2}$ -in. steel plate forms the body of the cell. In this is mounted a U-shaped cathode plate of perforated sheet steel, which also acts as the form for the anode compartment. The asbestos diaphragm is supported by the cathode plate and the ends of the U-shaped anode compartment are closed by blocks of cement mortar. An inverted, rectangular box formed of slate slabs closes the top of the anode compartment and also acts as a support for the graphite blocks which form the anode. The anode structure is so clearly shown in the illustration that it only remains to be said that the blocks are 4 x 4 x 17 in. and the lugs are 2 $\frac{1}{2}$  in. diameter by 12 in. long. It is to be noted that there is but one joint in the graphite, thus insuring maximum conductivity. The positive terminal is connected by means of a flat copper bar bolted to the lugs of the anode blocks, while a copper plate riveted to the perforated cathode performs a similar service for the negative terminal.

The latest built cells, like the illustration, are operated with an automatic feeding device which is very simple and which has proved to be entirely reliable. It consists of a strongly buoyant float on which is mounted a dull knife edge which presses against a bit of rubber tubing through which the brine is supplied to the cell. The slightest rise of the float cuts off the feed entirely and the least drop permits the flow to start again. No trouble is caused by dirt in the brine, because all of the brine is purified before passing to the cells, it being quite essential in the operation of any electrolytic cell for chlorine manufacture that iron, alumina, lime and magnesia be substantially absent.

The brine percolates through the diaphragm and the rate of flow is kept uniform by means of an atmosphere of steam that is maintained in the cathode compartment. This steam also helps dissolve the caustic soda formed at the cathode as well as heating the cell and thus reducing the resistance of the cell. In case the pores of the diaphragm begin to close, as will be shown by excessively strong caustic liquor, they can be freed by increasing the amount of steam.

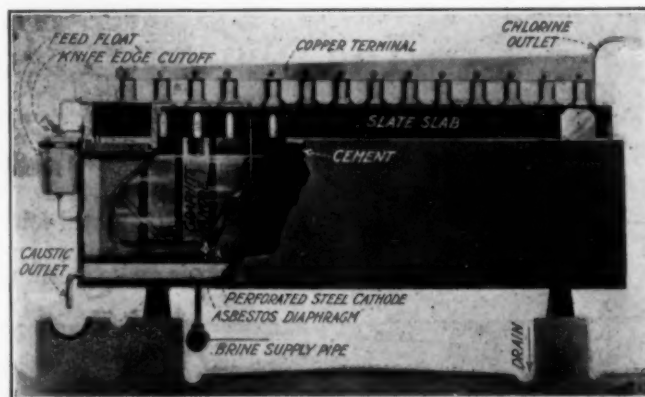


FIG. 2. NELSON CELL

The normal operating period between renewals of the diaphragm is from six to eight months and during this time the operating conditions remain practically constant. The cells are rated at 1000 amp., at which point the most efficient results are obtained, but they can be run as low as 600 amp. without serious loss of efficiency and will stand a continuous overload of 10 per cent without damage to plant or product. The voltage drop, averaging the switchboard reading and including all connections and cables, for a series of sixty cells, is from 3.5 to 3.8 volts and will usually average 3.7 volts over a period of six months. Only careless operation will cause an increase of more than 0.2 volt in the course of a six months' operating period.

The commercial guarantee under which these cells are sold specifies that, when operated at 1000 amp. and supplied with not to exceed 120 lb. of salt, each cell will produce 60 lb. of chlorine and 68 lb. of sodium hydroxide per 24 hours. For the first few days the caustic liquor flows very freely and is abnormally high in salt, but when the cells have reached normal working conditions the liquor will contain 10 to 12 per cent NaOH and 16 to 14 per cent NaCl.

#### TECHNOLOGY AND SPECIAL FEATURES

The normal operating period is six to eight months. At the end of this period it is considered better to renew the diaphragms and wash out the cells even if the operating conditions still seem very good, for they may become worse very rapidly if the period is stretched too far. The ordinary anodes are simply impregnated to prevent the electrolyte from creeping to the copper contacts, and only part of these will last more than two operating periods, that is, 12 to 15 months. A new process of treating the graphite has been perfected which increases the life of the anode to more than two years.

One of the greatest features of this cell is that it can be shut down either accidentally or intentionally for short or for long periods as often as desired without damage to the cell or serious loss of efficiency. To the best of our knowledge this is the only commercial chlorine cell that can stand frequent shut-downs without serious consequences.

**Simplicity of Structure:** Few, simple parts usually mean quick installation and low repair costs. The former was well illustrated at the Edgewood Arsenal plant and the latter has been borne out by the cost records of several large plants over long periods of operation. It also keeps down installation costs and operating expense, as it is possible to operate with ordi-

<sup>2</sup>See CHEM. & MET. ENG., Vol. 21, No. 1, July 1, 1919, p. 17.



nary labor. There are no moving parts and the entire structure is rugged and durable.

**The Anode:** The anode is made up of the most economical shape and size of graphite obtainable. Any change in the relative dimensions results in a higher price per lb. The machine work is extremely simple, permitting rapid production with minimum labor. The original appearance of the anode blocks can be seen in the illustration of the cell and in the center of the two illustrations showing anode blocks only. Illustration No. 3 shows

a set of anode blocks with no special treatment which have been run 12 months without renewal of the diaphragm. Illustration No. 4 shows a set of specially treated anodes which have been in service six months before the diaphragm was changed and then for a year before the second diaphragm renewal. They are apparently good for another year at least.

**Life of the Cell:** The life of the tanks is not definitely known, as some over ten years old are still in service and it is estimated that they will last twenty years. The screens last two to five years except when an accidental local electrolytic action occasionally causes a local hole that would cost more to repair than the cost of a new screen. The asbestos diaphragms are put in new every six to eight months when the cells are washed out. The new process anodes give efficient service for two to three years. The life of the other miscellaneous parts is largely dependent upon the care with which they are handled and operated.

**Floor Space:** Allowing ample aisles, the production of chlorine per square foot of floor space per 24 hours is about 2½ lb. A high floor space factor means a saving in installation of piping, bus-bars, etc., per unit of output.

**Attendance:** With cells provided with the automatic feed controls, one attendant is ample for two hundred. At the plant of the Warner-Klipstein Chemical Co., South Charleston, W. Va., there is only one attendant for 480 cells.

**Quality of the Chlorine Gas:** As previously mentioned, this cell was specially developed to produce relatively pure chlorine gas for the manufacture of chemicals. How successfully this was accomplished may be judged from the fact that large groups of cells have been run for periods of several weeks with the gas analyzing 99.5 to 99.8 per cent Cl and have been operated continuously producing gas averaging 99 per cent pure. Only ordinary precautions are required to keep the gas substantially free from air, without permitting the escape of chlorine gas into the atmosphere of the cell room.

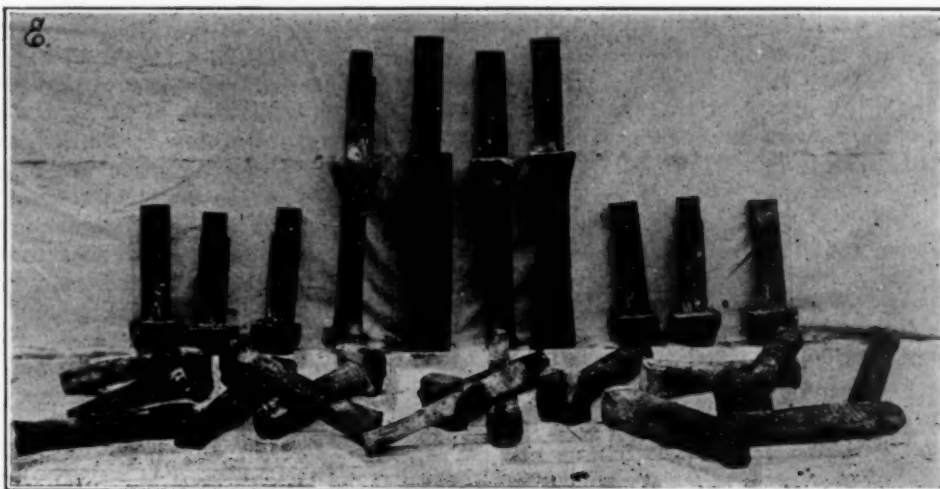


FIG. 3. ORDINARY ELECTRODES AFTER 12 MONTHS' SERVICE

**Quality of the Caustic:** A considerable amount of undecomposed salt of course passes into the caustic liquor from all diaphragm cells, but this is readily removed in the evaporator. Far more serious is the presence of chlorates or hypochlorites. In spite of the high temperature at which these cells operate, chlorates are not found in the caustic and it is very rarely that hypochlorites can be detected. The surest hypochlorite indicator is the life of the tubes in the evaporator, even small amounts of hypochlorite greatly shortening the life of the tubes. In some caustic plants this is a serious problem, but with this cell a life of two years is not uncommon.

**Efficiency:** Theoretically 1000 amp. require 115 lb. of NaCl and should produce 69.86 lb. Cl and 78.67 lb. NaOH. Plant records actually show about 90 per cent ampere efficiency and 60 per cent energy efficiency.

The energy efficiency is the important figure. Several commercial cells operate, or claim to operate, at higher ampere efficiencies than the Nelson cell, but the gain is wholly illusory if the energy efficiency drops to 55 per cent at the same time. In one case the energy consumed is 1.53 kw.-hr. per 1 lb. of Cl, and in the other case 1.67 kw.-hr. are required, even though the ampere efficiency was 5 per cent better. This means a saving of nearly 5c. per cell per day, or about \$4,000 per year in a plant producing 6 to 7 tons chlorine per day, assuming power to cost \$0.005 per kilowatt-hour.

The operating data over a long period at one plant gave an average voltage drop of 3.7 volts per cell over a period of six months, varying from 3.5 to 3.8 volts. The high average energy efficiency is due to the fact

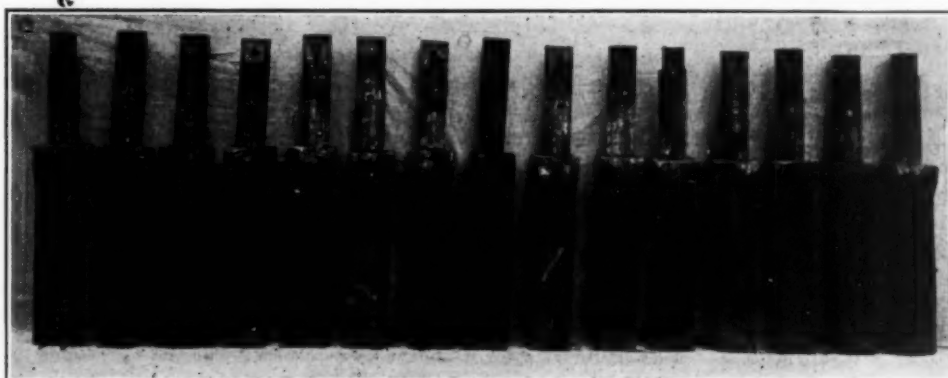


FIG. 4. TREATED ELECTRODES AFTER 18 MONTHS' SERVICE

that the cells start at a very low voltage which remains almost constant up to the end of the operating period.

Assuming that 2.3 is the correct factor for the theoretical decomposition voltage of NaCl in a water solution, the energy efficiency at 3.7 volts is 62 per cent and at 3.5 volts is over 65 per cent.

#### CONCLUSION

It is not claimed that absolute perfection has yet been obtained, but it is believed that this cell has reached a stage where experiment and abstract theory are things of the past. It is now a fully developed "machine" for manufacturing chlorine gas, that a chemical manufacturer can purchase as he would a filter press, a still, an evaporator or any other piece of standard chemical engineering equipment, and be assured of a fixed regular output of high quality, produced in a moderate costing, efficiently operating plant, which can be operated with ordinary labor with economical operating costs and repairs.

The author wishes to acknowledge the assistance of Mr. Nelson, who supplied some of the data and the illustrations for this paper, and also to thank the Warner Chemical Co. for the release of data and information.

## Water-Resistant Glues

BY F. L. BROWNE

UNTIL comparatively recently, practically all glues used in joining wood were the more or less impure forms of gelatin obtained by extraction from waste animal products such as hides, skins, bones, horns, hoofs, fish parts, etc. These glues are either of the solid or liquid type. For use the former are soaked in the proper amount of water, heated to a temperature slightly above their melting point, and applied to the surfaces to be joined, which are then put under pressure. On cooling and drying the glue film gives a strong joint. Liquid glues are applied cold and harden in the joint on drying.

Although gelatin glues of good quality yield very strong joints, they are subject to the disadvantage of softening to the extent of losing their holding power when kept in contact with much moisture, whether in the form of water or of high atmospheric humidity. Attempts have been made to increase the water resistance of gelatin glues by the addition of certain chemicals, but, although some progress has been made, satisfactory results have not yet been obtained. The only way so far found to make such joints serviceable under humid conditions is to keep the water away from them by using waterproof coatings.

The vegetable glues, made by heating starch (chiefly cassava starch) and water, in the presence of alkali lose their strength as gelatin glues do when exposed to humid conditions and can be made waterproof only by means of protective coatings.

Glued joints in an aeroplane are frequently subjected to very severe moisture conditions, and hence water-resistance is usually a large factor in the choice of an aeroplane glue. The known high strength and dependability of gelatin glues made it advisable to use them for propeller construction rather than glues whose characteristics were not so well known, especially since it was found possible to apply waterproof coatings. But for many plywood parts of aeroplanes, waterproof coating is not practicable, so that the use of water-resistant glue becomes a necessity.

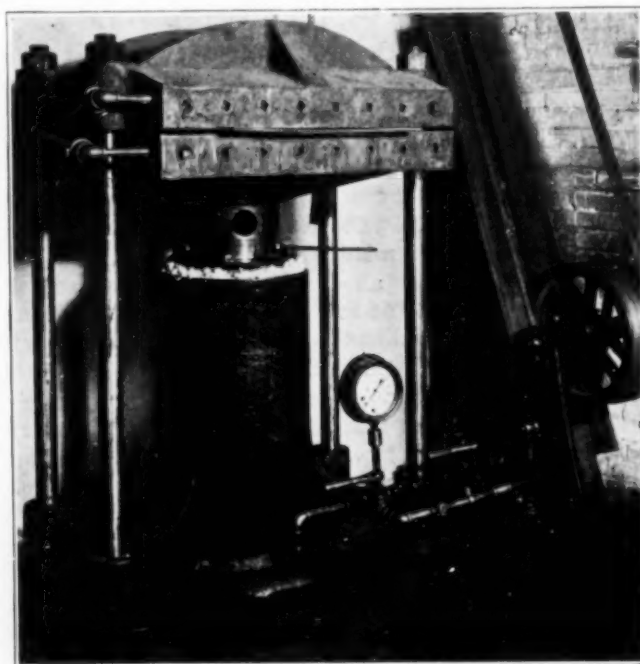
At present there are two types of these in use, one having casein as a base and the other blood albumin. These glues are water-resistant in the sense that the amount of water the dry glue films on the joints will take up is limited and the saturated glue still has sufficient strength to hold the joined surfaces together.

In order to control properly the quality of plywood glued with water-resistant glues and to develop glue production it was necessary for the Bureau of Aircraft Production to know how to make and use these glues. The Forest Products Laboratory of the U. S. Forest Service was therefore requested to investigate the subject. Research work was started late in 1917 and is still being continued. The following information is based on the results thus far obtained:

#### BLOOD ALBUMIN GLUE

Blood glues are a very recent development, in this country at least. The few plants using them before the war had their own secret formulas, and there has been very little information published on the subject.

Water-resistant glue can be made from fresh blood and where a supply is readily obtainable from a nearby slaughter house this may be the cheapest way to make



HOT PRESS FOR MAKING EXPERIMENTAL PANELS WITH BLOOD GLUE

it. The desirability and convenience of using the fresh blood, however, are open to question. Blood is subject to rapid bacterial decomposition, and hence where it cannot be utilized at once, it must be treated with a preservative or processed and the dried blood albumin used.

The material ordinarily used for making blood glue is the black soluble albumin which remains after subjecting blood to a process for removing the fibrin and part of the hæmoglobin or red corpuscles, and carefully evaporating to dryness. This material is not only cheaper than the albumin from which all hæmoglobin has been removed, but has been found to give a stronger glue. It is stable over a reasonably long period of time, but the solubility gradually decreases with age. Since only the soluble portion of the albumin forms



the essential glue-making material, freshly dried blood is more desirable. Loss of solubility likewise makes it impracticable to prepare blood albumin glue in the form of a dry powder ready for mixing with water.

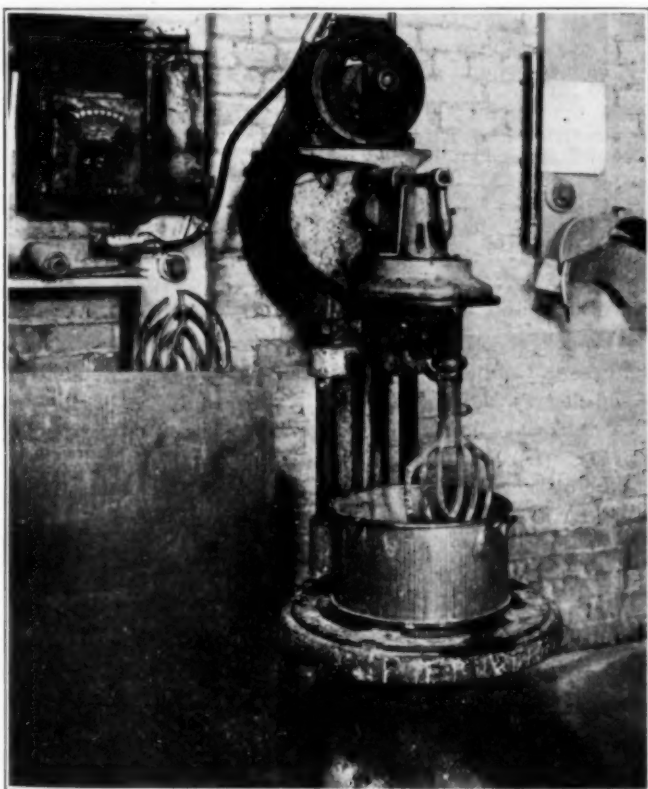
#### HARDENING BLOOD GLUE

Blood glue must be hardened by heating it to a temperature at which the albumin coagulates. This effect is ordinarily accomplished by the use of a hot press. The press commonly used is of the hydraulic type with hollow platens heated by steam. Blood glue is chiefly suited to plywood manufacture. Heavier joint work can be carried out, however, by clamping together the glued surfaces and subsequently placing them in a dry kiln or chamber at the proper temperature until the blood is coagulated.

Albumin coagulates at temperatures above 162 deg. F., but a temperature of about 212 deg. F. is usually employed in the press. For glues containing much inert material, temperatures as high as 300 deg. F. are sometimes used, but blisters are likely to result. A satisfactory pressure is about 150 lb. per sq.in. The time required for pressing depends upon the thickness of the outer plies; the thicker the plies the longer it takes for the heat to penetrate the wood and coagulate the glue. For  $\frac{3}{16}$ -in. 3-ply material,  $3\frac{1}{2}$  to 4 min. at 212 deg. F. are sufficient. The action of blood glue in hardening is the same as that which takes place in the white of an egg on boiling.

#### WATERPROOF GLUE

A waterproof glue can be made simply by dissolving blood albumin in water. The glue is improved, however, by the addition of a little ammonia and lime, and may be cheapened without great loss in strength by the addition of other ingredients. Too much lime must not be used, since it causes the mixture to set quickly to an unworkable jelly.



MIXER FOR CASEIN GLUES



MECHANICAL GLUE SPREADER IN OPERATION

A very satisfactory blood glue<sup>1</sup> is made by soaking six parts of black blood albumin in eleven parts of water for at least 2 hr., then stirring and passing the mixture through a 30-mesh screen to remove undissolved particles. One-fourth part of ammonium hydroxide solution (specific gravity 0.90) and 0.18 part of hydrated lime are then stirred in. The lime is added in the form of a thick cream made by mixing the powder with a little water.

#### CASEIN GLUE

Casein glues seem to have been known for a much longer time than blood glues, especially in Europe, but have not found any great use, so far as is known, until the last few years. During the war they have been used in American, British, French, Italian and German aeroplanes. Much more information is available in the chemical literature and old patents on this subject than is the case with blood glue.

Casein is a by-product of the dairy industry, obtained either from buttermilk or skim milk. Most of it comes from skim milk. The casein is precipitated by adding rennet, or acids, such as sulphuric or hydrochloric, or by allowing the milk to sour naturally, forming lactic acid from the milk sugar. There are many slight variations in the technique of the processes, so that the product obtained on the market is not uniform, the chief variation being in the ash content and the acidity. This variation frequently makes necessary slight changes in proportions in using different shipments of casein in a given glue formula.

Casein is very closely related chemically to albumin. It does not show such definite coagulation on heating; as in the case of albumin, however, certain chemicals have the property of causing its solutions to harden, forming jellies. Some of the casein jellies after drying will absorb only a limited amount of water. Casein glue is mixed at ordinary temperatures and the joints are pressed without heat until the glue has hardened, then they are dried down to the moisture content desired in the finished product.

<sup>1</sup>Government patent in the name of S. B. Henning, Forest Products Laboratory, applied for.

Casein glues may be divided into two classes: (1) "Wet" glues, in which the various ingredients are kept separate until the glue batch is to be made up for immediate use; and (2) "dry" glues, in which all the ingredients except the water are mixed to form a dry powder which can be kept until ready to use and then merely mixed with water.

A very simple but effective wet glue can be made using simply lime and casein, but it is open to the serious objection that its working "life" is only from 15 to 45 minutes. At the end of this time it has hardened to an unworkable jelly. The following formula for a wet glue has given very excellent results:<sup>1</sup>

100 parts casein	Soak 15 minutes	} mix	} mix
130-280 parts water			
15-22 parts hydrated lime			
90 parts water			
70 parts sodium silicate (water glass)			

The casein is soaked in the water until thoroughly wet, the lime water is stirred in, and the sodium silicate added last. Stirring is continued until a smooth mixture, free from lumps, is obtained. The amount of water in which the casein is soaked as well as the quantity of lime used depend upon the composition of the casein, particularly upon its ash content. The life of this glue is usually about 8 hours.

In mixing dry glues, the powder is stirred into the proper amount of water until a smooth liquid results. With all casein glues, it is important that the mixing be done thoroughly so that the casein will be completely dissolved and the glue free from lumps. For the purpose a power cake mixer has been found to give very satisfactory results.

#### COMPARISON OF BLOOD AND CASEIN GLUES

Blood glue has the disadvantage, as compared with casein glue, of requiring hot pressing, which limits the output of the press and makes it less easily used for such joint work as gluing propeller laminations. Blood glue is not readily obtainable as a dry glue, whereas casein is. Casein glue has been somewhat less expensive, but a considerable amount of cheap inert matter can be introduced in blood glue without serious loss of strength. In the matter of water-resistance, blood glue possesses a slight advantage. Although blood and casein glues are more expensive than vegetable glue, their water-resistance will give them a wide application in the future. They are both in the early stages of development still, and much improvement in both cheapness and water-resistance may be looked for.

Forest Products Laboratory,  
Madison, Wisconsin.

#### Bibliography on Casein and Casein Glues

- "The Physical Chemistry of the Proteins." (1918 ed.) T. B. Robertson.  
 "General Characteristics of Proteins." Schryver.  
 "Chemistry of the Proteids." Mann.  
 "Chemical Constitution of the Proteids." Plimmer.  
 "Casein and Its Primary Cleavage Products." Chittenden.  
 "Caseoses, Casein, Dyspeptone, Etc." Chittenden.  
 "Chemie der Eiweisskörper." Cohnheim.  
 "Dairy Chemistry." Richmond.  
 "Commercial Organic Analysis." Allen.  
 "Dictionary of Applied Chemistry." (Latest ed.) Thorpe.  
 "Physiological Chemistry." Hammarsten-Mandel.  
 "Physiological Chemistry." Hawk.  
 "Industrial Chemistry." Rogers & Aubert.  
 "General and Industrial Chemistry." Molinari.  
 "Casein, Its Preparation and Technical Utilization."\* Scherer.

<sup>1</sup>Government patent, U. S. No. 1,293,396, granted S. Buttermann, Forest Products Laboratory, Jan. 14, 1919.

\*Contains information on casein glue.

- "The Manufacture of Casein From Buttermilk or Skim Milk." Dahlberg, U. S. Dept. of Ag. Bul. No. 661.  
 "Agglutinants of All Kinds, for All Purposes." Standage.\*  
 "The Colloid Chemistry of Casein."—Stocks, Report of Report of British Association for the Advancement of Science, 1917-1918, p. 88.  
 "Casein and Its Technical Applications."—Marotta, *Annali di Chimica Applicata*, v. 6, p. 165.  
 "Casein, Its Utilization in the Paper Industry." *World's Paper Trade Review*, v. 46, pp. 281, 657.  
 "Casein." Reuter, *Papier-Zeitung*, v. 32, pp. 3286, 3374.  
 "Casein and Its Applications." Richardson, *Journal, Soc. Dyers and Colorists*, v. 25, p. 48.  
 "The Technical Production and Utilization of Casein." Kühl, *Südd. Apoth. Ztg.*, v. 52, p. 390.  
 "New York Produce Review and American Creameries," v. 31 (1), p. 12.  
 "Technical Casein, Its Examination and Utilization." Höpfner & Burmeister, *Chem. Zeit.*, v. 36, p. 1053.  
 "The Nitrogen Factor for Casein." Vaubel, *Zeit. öffent. Chem.*, v. 15, p. 53.  
 "Investigations of Casein and Curd." *Milch. Zentr.*, v. 6, p. 386.  
 "The Composition of Acid Curd." *Zeit. Nahr. Genussm.*, v. 22, p. 170.

#### PATENT LITERATURE ON CASEIN GLUES

- U. S. Patent 838,785 }  
 845,790 } Isaacs, 1906  
 848,746 }  
 183,024 Ross  
 21,744 Gardner, 1896  
 609,200 Hall, 1896 (Reissue 11, 811, 1900)

#### BIBLIOGRAPHY ON ANIMAL GLUES

- "Agglutinants of All Kinds for All Purposes." Standage, 267 pages, published by D. Van Nostrand, New York, 1907, \$3.50.  
 "Glue, Gelatine, Etc." Dawidowsky, 282 pages, published by Henry Carey Baird & Co., 810 Walnut Street, Philadelphia, Pa., 1905, \$3.00.  
 "Glues and Gelatines." R. L. Fernbach, 200 pages, published by D. Van Nostrand, New York, 1907, \$3.00.  
 "Glue and Glue Testing." Samuel Rideal, 140 pages, published by Scott, Greenwood & Son, London, 1901, \$4.00.  
 "The Glue Book." J. A. Taggart, Toledo, Ohio, 85 pages, published by the Republican Publishing Co., Hamilton, Ohio, 1913, \$1.00.  
 "Specifications and Tests of Glue." Linder and Frost, *Proceedings, American Society for Testing Materials*, 1914, Part 2, pages 509 to 519.  
 "A Study of Various Tests Upon Glue." A. H. Gill, *Journal Industrial and Engineering Chemistry*, 1915, pages 102 to 106.  
 "Glue for Use on Airplanes." P. A. Houseman, *Journal Industrial and Engineering Chemistry*, 1917, pages 359 and 360. Republished in *Aviation*, July 1, 1917, pages 494 and 495; and in *Aerial Age Weekly*, June 18, 1917, page 462.  
 "The Grading and Use of Glues and Gelatines." Jerome Alexander, *Journal, Soc. Chem. Ind.*, Feb. 28, 1906.

#### Tennessee Copper Co. to Enter Fertilizer Field

At present all of the sulphuric acid produced by the Tennessee Copper Co., amounting to about 360,000 tons of 50-degree acid annually, is being delivered to the International Agricultural Chemical Co. at the old contract price of \$4.81 a ton. At the expiration of that contract in December, 1920, the company will manufacture acid phosphate and, since the acid plant is the largest in the world, it will undoubtedly become one of the leaders in the fertilizer field. Phosphate rock will be obtained from the extensive deposits of the Stuart-Memminger interests in Polk County, Florida, which have been purchased recently by the Tennessee Copper & Chemical Corp. The tonnage of rock already proved in these properties will take care of the company's requirements for a long time to come.

\*For a description of the acid plant see CHEM. & MET. ENG., Vol. XIX, p. 404.

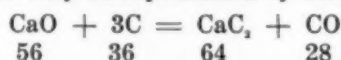


## Carbide Conversion Calculations

BY ISMOND E. KNAPP

IN CARRYING on experimental work in connection with the manufacture of calcium carbide, considerable time was consumed in making the necessary calculations. Changes were being made in the design of the furnace, and it was important to know the efficiency of conversion that was obtained in each run. Inasmuch as the quality of the coke and lime varied considerably, this calculation was rather tedious. In order to simplify it, the following method was worked out, and it has proved entirely satisfactory.

The reaction may be represented by this equation:



Analysis shows that the crude carbide or furnace product contains only a small amount of free carbon (seldom over 1.0 per cent) and but very little sulphur. These small amounts are neglected in these calculations, and it assumed also that all of the constituents in the coke ash and the impurities in the lime (such as  $\text{SiO}_2$ ) go through the carbide furnace unchanged, and are present in the furnace product. On this basis the furnace product will have only the following constituents:

- (1) Calcium carbide.
- (2) Coke ash.
- (3) Lime impurities.
- (4) Unchanged lime.

Let  $A$  = decimal fraction fixed carbon in the coke.

$B$  = decimal fraction ash in the coke.

$C$  = decimal fraction  $\text{CaO}$  in the lime.

$D$  = decimal fraction loss on ignition of the lime.

Then,  $1 - A - B$  = moisture + volatile + sulphur in the coke and  $1 - C - D$  = impurities in the lime.

It is evident from the above equation that the theoretically correct proportions for a mixture of lime and coke are:

$$\frac{36}{A} : \frac{56}{C}$$

In case the proportions actually used are not the theoretical, care must be taken that they are calculated to the above form, and that only the factor 36 is affected. For instance, if a small excess of carbon were used, this factor might become 37 or 38. It can be determined easily by solving this proportion:

$$\frac{\text{lb. lime used} \times C}{\text{lb. coke used} \times A} = \frac{56}{36}$$

whence,  $X$  = the factor to be used in place of 36 in all of the following formulæ.

Assuming that the efficiency of conversion,  $E$ , is known, then the weight of  $\text{CaC}_2$  in the furnace product from a coke-lime mixture of the above composition will be  $64E$ . The weight of the coke ash will be  $\frac{36}{A}B$ ; the weight of the impurities from the lime will be  $\frac{56}{C}(1 - C - D)$ ; and the weight of the unchanged lime will be  $(1 - E)56$ . The corresponding amount of unchanged carbon,  $(1 - E)36$ , apparently is burned, and so does not appear in the furnace product. Now, if  $F$  represents

the total weight of the furnace product, we may write:

$$F = \text{carbide} + \text{ash} + \text{dead lime} + \text{excess lime} \\ = 64E + \frac{36B}{A} + \frac{56(1 - C - D)}{C} + (1 - E)56 \quad (I)$$

The purity of the furnace product,  $P$ , is of course the ratio of the weight of  $\text{CaC}_2$  in the furnace product to the total weight of the furnace product, i.e.

$$P = \frac{64E}{F}$$

or, substituting the above expression for  $F$ ,

$$P = \frac{64E}{64E + \frac{36B}{A} + \frac{56(1 - C - D)}{C} + (1 - E)56}$$

By rearranging this equation we finally obtain:

$$E = \frac{P\left(\frac{36B}{A} + \frac{56(1 - C - D)}{C} + 56\right)}{64 - 8P} \quad (II)$$

$A$  and  $B$  are known from the coke analysis;  $C$  and  $D$  are known from the lime analysis; and  $P$  is known from the analysis of the crude carbide. Hence the efficiency of conversion can be calculated quickly by simple substitution.

The following example will show the practical application of the foregoing formula:

Data:

Coke analysis: 0.903 fixed carbon, 0.069 ash.

Lime analysis: 0.768  $\text{CaO}$ , 0.177 loss on ignition.

Mixture ratio: 200 lb. lime to 130 lb. coke.

Charged into furnace: 766 lb. of above mixture.

Recovery: 459 lb. crude carbide.

Analysis of product: 0.076  $\text{CaC}_2$ .

Calculations:

$$\frac{200 \times .768}{130 \times .903} = \frac{56}{X}, \text{ whence } X = 36.3$$

Then the proportions in the mixture are  $\frac{36.3}{A} : \frac{56}{C}$

$A = 0.903$ ;  $B = 0.069$ ;  $C = 0.768$ ;  $D = 0.177$ ;  $P = 0.760$ .

Then by formula II,  $E = 0.824$  or 82.4 per cent efficiency of conversion.

As a check on the above calculation it is often of interest to go back and calculate the weight of the furnace product, using formula I for  $F$ . The result thus obtained should show a fairly close agreement with the weight of furnace product actually obtained. The writer has checked repeatedly within 3 per cent in this manner.

For instance, in the example given above, the weight of the charge can be computed thus:

$$\frac{36.3}{A} + \frac{56}{C} = \frac{36.3}{0.903} + \frac{56}{0.768} = 113.1$$

By formula I,  $F = 69.4$ .

The weight of the charge actually used was 766 lb.

Hence,  $113.1 : 69.4 :: 766 : X$ .

Whence,  $X = 470$  lb. theoretical weight of the furnace product. This result shows a variation from the weight of the crude carbide actually obtained (459 lb.) of 2.3 per cent.

Sometimes it is desirable to know the maximum purity of the crude carbide that can be obtained from given raw materials, with an efficiency of conversion of 100 per cent. This can be found by putting  $E = 1$

in the above formula for  $P$ , which then reduces to

$$P_{max} = \frac{64 \times 1}{64 + \frac{36B}{A} + \frac{56(1-C-D)}{C}}$$

In the example given above the maximum purity obtainable is 90.4 per cent.

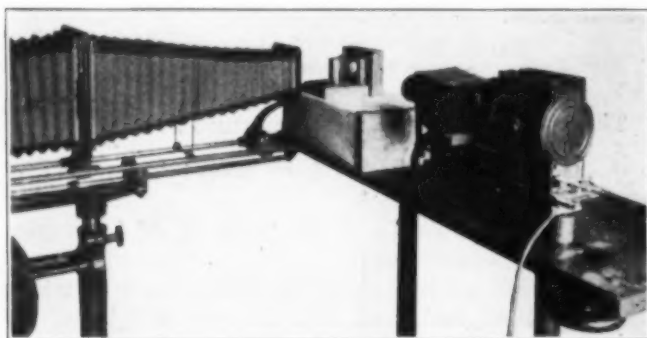
Although a high degree of accuracy is not claimed for these formulæ on account of the assumptions made regarding the chemical changes in the carbide reaction, nevertheless they have proved very helpful in the work for which they were developed.

Wilmington, Del.

## The Photographing of Etched Sections of Steel Forgings at Low Magnifications\*

BY FRANCIS B. FOLEY  
Metallurgist, Bureau of Mines

IT IS frequently found desirable to examine certain coarse-grained steel, for example steel in the forged condition, under low power for the purpose of getting a better comparison of grain size than is usually brought out in examining such steel by the microscope at magnifications of 50 diameters and higher. The desirability of low-power examinations of forgings became evident in recent investigations by the Bureau of Mines, where a grain size was found under the microscope which was difficult to record by photographing because the field covered by the microscope was too restricted, very often not sufficiently large to take in a single grain. An effort was therefore made to find a method of



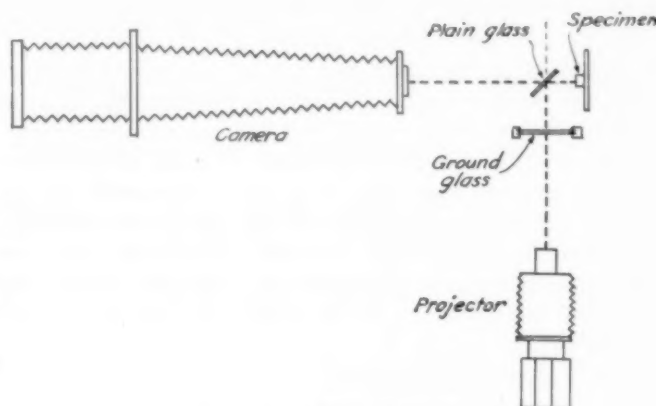
INSTRUMENTAL SETUP FOR PHOTOGRAPHING CROSS-SECTION OF TEST PIECE

photographing a large area of the etched section without losing the relative value of the microconstituents. The apparatus that resulted was cheap and crude, but productive of excellent results, as may be observed in the accompanying illustrations, and, while the method adopted was not remarkable for its originality, it seems worthy of description and attention, since it appears that the photographing of etched specimens of steel at magnifications as low as 7 diameters by vertical illumination has not been practiced to any extent, at least not to the writer's knowledge.

The apparatus with a specimen in place for photographing is shown in the half-tone illustration in this column. The illuminator should be of optically flat glass or glass in which there are no undulations which will interfere with the proper refraction of the

light rays or with the focusing of the image. The illuminator used in taking the photographs shown in Figs. 1, 2, 3, 4, 5 and 6 was a small lantern slide from which the emulsion had been removed. A fairly bright, well diffused light is desirable and, in this connection, a ground glass diffusing screen is of considerable help. The light in the stereopticon lantern shown in the illustration is a 110-v. 400-w. lamp. The exposures, without a ground glass screen, were of 30 to 45 seconds duration.

The remarkable variation which can be brought about in the condition of forged steel by improper or lack of temperature control stands out prominently when the large field which it is possible to cover at low magnification is offered for study. Fig. 1 represents the



PLAN OF APPARATUS

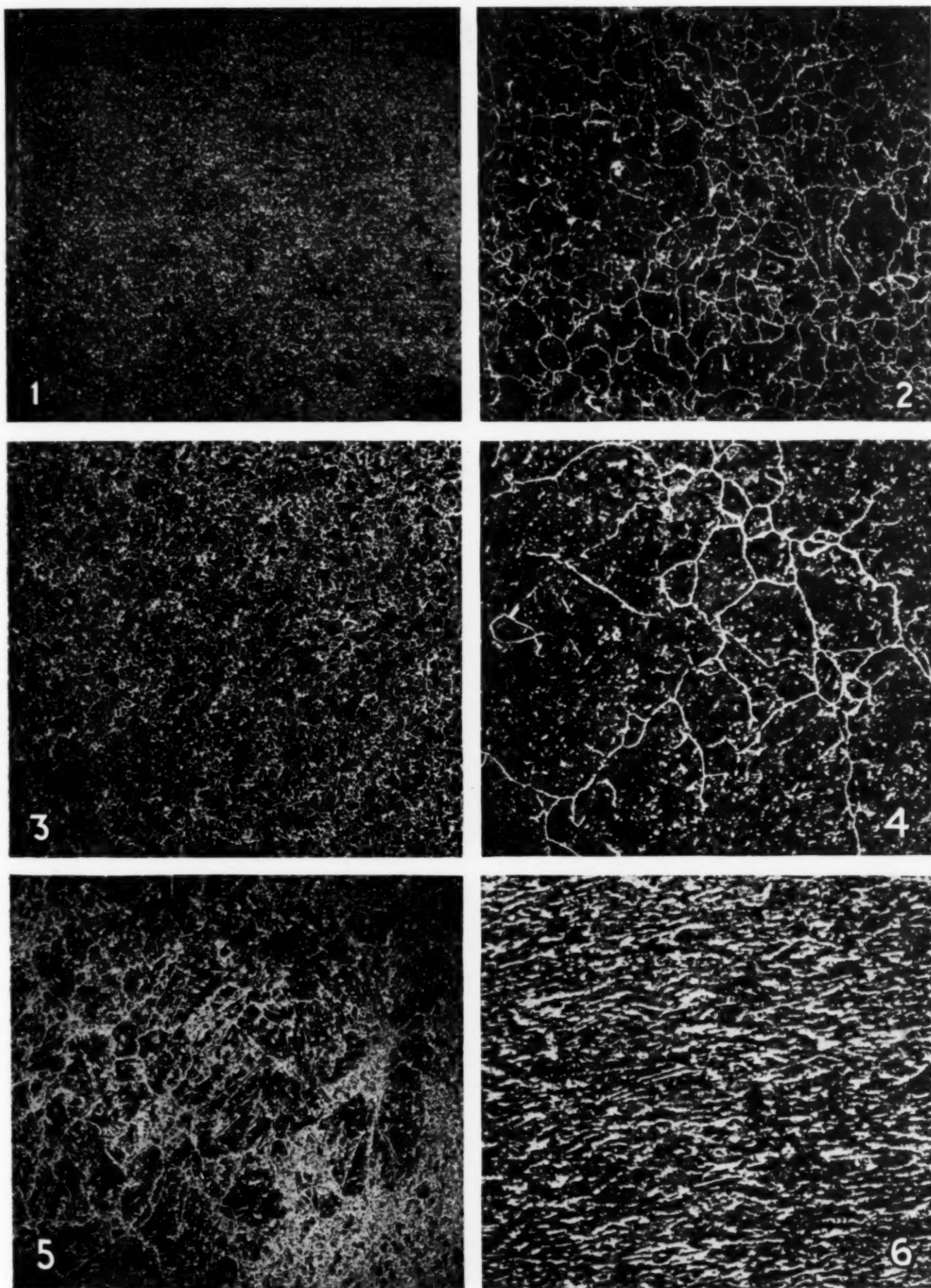
structure of a bar taken from an untreated forging, which, without heat treatment, gave an elongation of 18 per cent, and Fig. 2 the structure of a bar from the other end of the same forging, which gave an elongation of but 5 per cent. Were the entire forging in the condition represented by Fig. 1 a very simple heat treatment would suffice to put it in the best condition, but the condition shown in Fig. 2 makes it necessary to go to much greater trouble and expense to bring about a desirable structure. The platy arrangement of the ferrite in Fig. 6 is brought out to a better advantage in the 7-diameter magnification shown here than it could be in a small area at high power. The composition of the steel shown in this photograph was unusual only in sulphur, which was 0.05 per cent, whereas the usual product ran sulphur below 0.03 per cent. Figs. 1, 2, 3, 4, 5 and 6 do not represent specially selected forgings or structures which have been produced in a predetermined manner, but random selections from forgings put through the usual course of manufacture at the plant where the forgings were made. All are of 3 per cent nickel gun steel of 0.35 to 0.40 per cent carbon and have had no heat treatment subsequent to the forging operation and serve well to show the wide variation in structure which heat treatment is called upon to correct.

Etching for photographing in the manner described here has been done with the usual picric acid reagent, but the etching has been carried deeper than is usually done for ordinary microscopic examination. The pearlite areas are etched quite dark, but if the specimen is thoroughly washed in water after etching, preferably under a running stream, and then dried, the structure developed is very good for examination at high power in spite of the very deep etch.

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Pittsburgh, Pa.





FIGS 1 TO 6.

Types of structure found in 0.35 to 0.40% C, 3% Ni steel gun forgings before heat-treatment. Figs. 1 and 2 represent opposite ends of the same forgings. Picric acid etching. Magnification 7 diameters.

## Exposure Tests of Sheet Metal

Description of the Standard Sheet Metal Tested and Method Followed—Results Graphically Charted—  
Conclusion: The Best Sheet Metal Material Is a Copper Bearing Steel With 0.20  
to 0.25 Per Cent Copper

By SAMUEL L. HOYT, E.M., Ph.D.

Associate Professor of Metallography, University of Minnesota, Minneapolis, Minn.

FOR the past three years the writer has been conducting exposure tests of sheet metal with the object of ascertaining the relative behavior of various standard commercial products such as the bessemer and open-hearth sheets, pure open-hearth iron sheets, and copper-bearing steel sheets. The sheets used were obtained from various manufacturers in this country and were supposed to represent typical commercial grades of these materials. As far as is known, there is no reason to believe that they were other than as represented.

The test specimens were exposed continuously to the rain, snow and sunshine, in amounts which are shown by the curves in Fig. 1, which were plotted according to the data kindly furnished by Mr. U. G. Purcell of the United States Weather Bureau, Minneapolis Station.

The test specimens, taken from each sheet submitted, were placed in a rack on the roof of the School of Mines building on the campus of the University of Minnesota. The air is comparatively pure, the only contamination being from a railroad passing through the campus on which the service is infrequent, and from two power plants situated on the campus some distance away from the place of the tests.

### MATERIAL USED

Requests were made of leading producers to submit sheets of their standard sheet metal one yard square and in the condition in which they left the mill. These sheets came in both 20-gage and 26-gage. The compositions of these materials are given in Table I.

TABLE I. CHEMICAL ANALYSIS OF SHEETS

Mark	Gage	Material	C	Mn	S	P	Si	Cu
25	20	Pure iron.....	0.05	0.05	0.032	0.007	0.003	0.032
26	26	Pure iron.....	0.05	0.05	0.025	0.006	0.003	0.032
29a	20	Copper-bearing.....	0.12	0.49	0.034	0.065	0.028	0.224
29b	20	Copper-bearing.....	0.11	0.47	0.031	0.057	0.019	0.220
31	26	Copper-bearing.....	0.13	0.47	0.031	0.058	0.026	0.224
31a	26	Copper-bearing.....	0.13	0.47	0.034	0.057	0.026	0.220
33	20	Bessemer.....	0.09	0.45	0.041	0.092	0.003	0.008
33a	20	Bessemer.....	0.09	0.45	0.049	0.095	0.005	0.008
35	26	Bessemer.....	0.08	0.35	0.072	0.087	0.014	0.008
35a	26	Bessemer.....	0.08	0.35	0.072	0.087	0.014	0.008
37	20	Pure iron.....	0.038	0.034	0.030	0.007	0.005	0.040
38	26	Pure iron.....	Same as 37					
41	20	Copper-bearing.....	0.10	0.48	0.040	0.009	0.003	0.260
42	26	Copper-bearing.....	0.06	0.47	0.041	0.010	0.003	0.272
43	20	Pure iron.....	0.05	0.05	0.019	0.004	0.003	0.024
44	26	Pure iron.....	0.05	0.04	0.020	0.002	0.009	0.036
45	20	Open hearth.....	0.10	0.43	0.030	0.011	0.136	0.064
46	26	Open hearth.....	0.12	0.35	0.039	0.018	0.117	0.028

### CONDUCT OF THE TESTS

From each sheet submitted were cut a number of small specimens  $1\frac{1}{2} \times 3\frac{1}{2}$  in., and marked for identification according to Table I. These specimens in their natural condition were then weighed and placed in a rack on the roof of the School of Mines building. The specimens were arranged in rows numbered from I to X inclusive, each row containing one sample from each sheet submitted. At the end of the first period only the

specimens in the first row were taken down and the remaining specimens were not touched. After cleaning off the rust and weighing, the I specimens were replaced in their proper position in the rack. At the end of the second period the first two rows, or the I's and II's, were taken down and cleaned and weighed and then returned to the rack. This procedure was continued so that at the end of each period another additional row of specimens was taken down along with all those which had previously been taken down and cleaned and weighed and, in turn, all returned to their places in the rack. At the end of the tenth period the number X's were taken down for the first time, so that they had

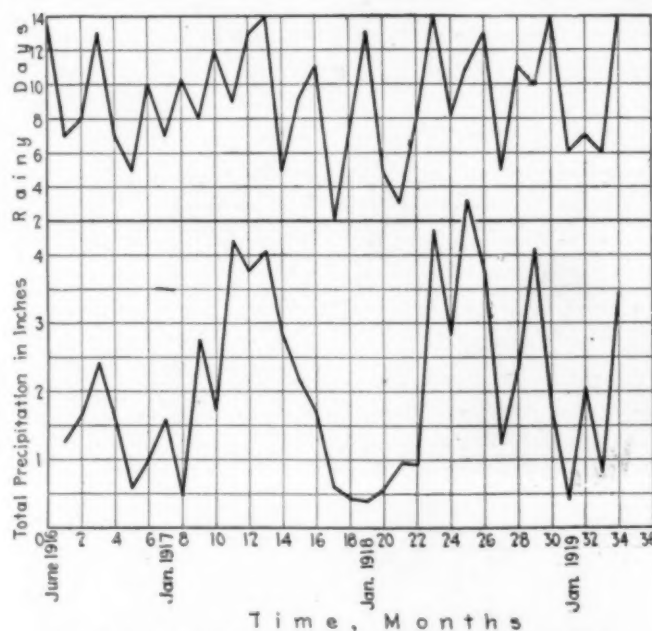


FIG. 1. WEATHER CONDITIONS DURING TEST

been exposed continuously, that is, without intermediate cleanings, for the entire period of three years. In this way the effect of leaving the rust coating on as well as of removing it could be ascertained.

### RATE OF CORROSION

The rate of corrosion was determined by noting the difference in weight before exposure and after removing the rust film. The loss in weight represented that portion of the specimen which had rusted or corroded over the corresponding time interval. The method used to remove the rust was that of treating in hot ammonium citrate, which as far as could be observed gave entirely satisfactory and comparable results. Other corroborative evidence of the rate of corrosion was obtained from the total failure of the specimens and their general appearance.



Fig. 4 is intended to show the rate of corrosion under continuous exposure, that is, without removing the rust film at the end of each period. It was necessary to take

a new specimen for each period represented so that the I specimen was taken at the end of the first period, and II at the end of the second period, the III at the end of the third period, and so on up to the X specimen at the end of the three years. It is hardly to be expected that these curves will show as uniform results as the I's or the II's or the III's, etc., plotted separately. The rate of corrosion in this case is appreciably less because the protective coating of rust is allowed to remain on the specimens for the full time for each period. The order of excellence of the 20-gage specimens in this series taken at the end of 36 months is 29b, 29a, 43, 41, 25, 33, 45, 33a.

Fig. 5 corresponds to Fig. 4 except that it represents the 26-gage sheets. Here again it will be noticed that certain of the specimens failed prior to 36 months. Samples 35 and 35a failed at the end of 15 months. The order of excellence of the specimens in this test is 31a, 31, 42, 44, 26, 46, 35a, 35.

In order to compare the relative resistance to corrosion of copper-bearing steel, pure open-hearth iron and plain steel, the various specimens were divided into these three classes and the average loss in the weight for each class calculated. The results obtained for the number I specimens are shown in Fig. 6, in which both gages are represented. The order of excellence, which remained the same for the entire period, is copper-bearing steel, pure iron, and plain steel.

Fig. 7 represents the average losses of these three types of materials at the end of each period in case the protective coating was allowed to remain on for the total time up to the end of the period. Here again slight

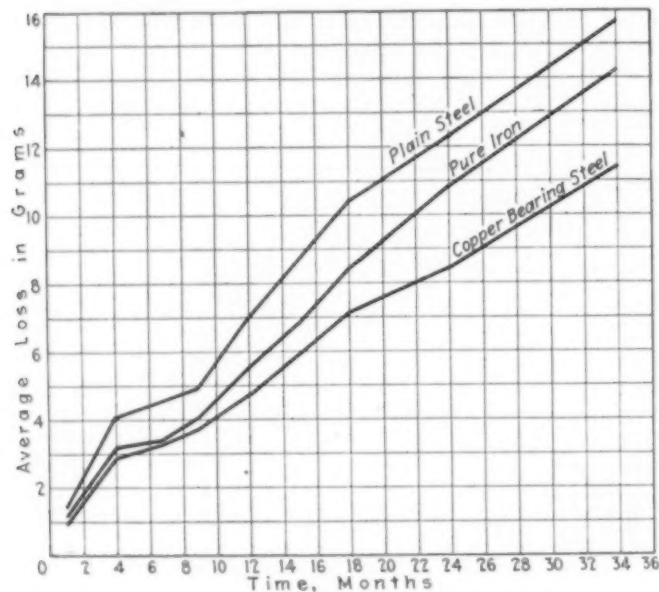


FIG. 6. RELATIVE RESISTANCE TO CORROSION; RUST REMOVED PERIODICALLY

irregularities may be noticed, but the same order of excellence is obtained, and this remains the same throughout the entire 36-month period. It is as before, copper-bearing steel, pure iron, and plain steel.

#### CONCLUSIONS

The general conclusion which, it is believed, may be drawn from this exposure test is that the so-called copper-bearing steel, in which the copper content is about 0.20 to 0.25 per cent, offers the greatest resistance to corrosion of the common sheeting materials. After

copper-bearing steel come pure open-hearth iron, open-hearth steel and bessemer steel in the order of excellence. As evidence of this fact we have the loss in weight, the ultimate failure of the materials and their general appearance both before and after removing the rust-coating. It was noted that while the copper-bearing

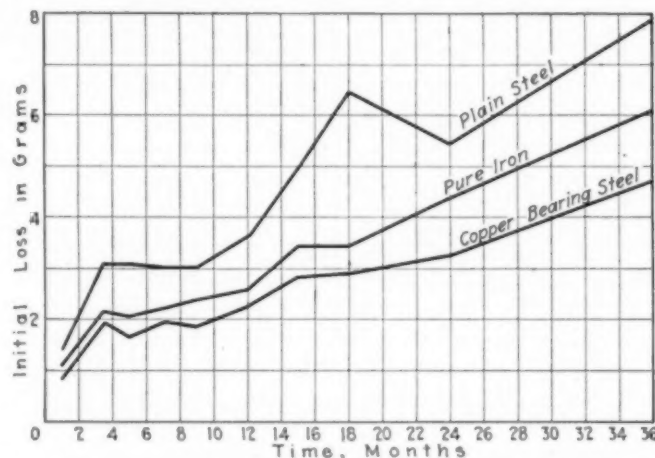


FIG. 7. RELATIVE RESISTANCE TO CORROSION; CONTINUOUS EXPOSURE

steel, as compared to the other materials, has a particularly dense protective coating of rust, the material itself has an abnormally low tendency to oxidize in moist air. On this account it is not sufficient to explain its resistance to atmospheric corrosion as being due primarily to the nature of the rust-coating. A more plausible explanation seems to be that the copper, by entering into solid solution in the iron, lowers the solution pressure of the iron. The physical character of the rust-coating may be merely a manifestation of the rate at which the coating is formed.

The two best sheeting materials, according to this test, are copper-bearing steel and pure iron. Aside from the superiority of the former, it may be of interest to note that, from the metallurgical point of view, it is both cheaper and more economical of time and materials to produce copper-bearing steel, as compared to pure iron. Thus heats of copper-bearing steel can be made according to standard practice and in standard time with a final addition of about a dollar's worth of copper per ton of steel. Pure iron, on the other hand, is a difficult product to make on a large commercial scale and requires high temperatures and something like 20 to 24 hr. per heat. Both as regards resistance to atmospheric corrosion and cost of production, copper-bearing steel seems to possess a decided advantage over pure open-hearth iron as a sheeting material.

#### Japanese Developing Steel Industry

The American Chamber of Commerce in London understands that a British naval correspondent in Japan foresees the end of Japan's dependence on steel imported from the United States and Great Britain. The Japanese are said to be exploiting on a large scale the ores which they have discovered in Korea and to be making extensions of their industries to handle this new source of supply. Ore concessions in China will further increase the Japanese raw material. This British correspondent predicts not only that Japan will soon be independent of outside sources of supply but that in another 10 years' time she will be exporting cheap steel to the Pacific markets.



## Flakes in Alloy Steel

**A Recapitulation and Discussion of Recently Published Matter About This Baffling Defect Appearing in Gun Tubes and Other Large Forgings of Alloy Steels—There Are Probably Two Kinds of Real Flakes, but Only One Kind Which Is Dangerous**

By ERNEST EDGAR THUM

TWO years ago an enormous expansion in our ordnance program caused many concerns to produce large alloy-steel ingots and forgings—a class of output entirely new to them. As an instance, high-strength gun tubes were needed in great numbers, to the most exacting specifications, requiring test bars cut at right angles to the axis. Immediately there appeared bright silvery areas in otherwise normal test bar fractures, associated with low and variable elongation and contraction in area, causing rejection of a tremendous tonnage even though the elastic limit was unaffected and the ultimate strength lowered but slightly. Failure of more than half the production to pass acceptance tests caused earnest inquiry on many sides, despite the fact that many production-mad concerns profited as much from bad forgings as from good.

Coarse crystalline areas in fine crystalline breaks have been noted before—indeed, can be produced at will by straining a portion of sound metal to a critical point, followed by continued annealing below recalcence. But the defects in question appear to have little depth; the so-called flake often exhibited warped surfaces such as the rounded corners and ends of squeezed macro-crystals. Numerous names were given them, they seemed to occur at different stages in the history of the piece, from a wide variety of causes, and the whole situation was fraught with the most extreme confusion. Most investigators now agree, however, that a flake results from a series of intercrystalline cracks, produced by stresses set up in the metal by its treatment, the location being determined by points of weakness already existing; in other words, a flaky steel contains a series of internal “bursts” in heterogeneous metal. Homogeneity is the obvious remedy; given sound ingots and barring amateurish forging and heat treatment or rough handling, a piece free of this defect should result. Actually this was the case; fewer and fewer rejections came with continued experience.

### EXISTENCE OF TWO KINDS OF FLAKES

If, then, a flake is an intercrystalline crack, does it exist as a crack in the metal during and after its fabrication, or is it a plane of weakness which spreads from a minute parting only on stress? Probably both. The evidence suggests that there are two kinds of flakes; the one due to actual cracks in clean metal and the other to inclusion films. Large cracks pre-existing in a test piece will evidence themselves by correspondingly low values for elastic limit and ultimate; eliminating from this discussion, however, the unwelded tears due to unreasonable reduction and rough handling, a true flake is something which does not lower the elastic limit of the test piece materially. But take a good ingot, saw through it parallel to the base and polish this new section. Without any etching will appear short hair-

lines in the polished surface, doubtless traces of actual partings.

Such tiny cracks have a habit somewhat depending upon the shape of the ingot; probably they are due to stresses thrown into the shrinking metal as it cools through the tender heat just below recalcence; the exact nature of these stresses is somewhat obscure, however, and a variety of opinion exists. However, in a given heat, such flakes will appear independently of the size, shape and method of pouring; being deep seated, they may be welded shut if high-temperature forging is sufficiently penetrating and the burst contains no oxidized inclusions. Clean small cracks in the ingot should thus constitute no insurmountable defect in the metal. Ultimately they may be due to a certain homogeneity in the metal, and are thus closely related to flakes due to inclusion films, although in the former case the heterogeneity may be a normal incident of perfectly well-made metal.

Rawden, however, finds a very thin film of slag at the ends of flakes in forged tubes. This inclusion evidently permits the original separation and later prevents proper welding, as well as forming an internal notch inducing premature failure under stress. Other observers also note evidence of slag in flaky fractures, and describe flakes as a recrudescence of local crystalline fractures due to the presence of slag—known for some time. Metal in contact with such slag inclusions generally shows a structural change—usually a decarburization—and such spots may well provide the nuclei from which fracture starts. On the other hand much “dirty” steel containing large quantities of solid non-metallic impurities is not flaky, while many observers are positive that slag particles of microscopic size are not universally present in flakes.

### WHAT CAUSES FLAKES

While it is a favorite method to ascribe visible effects to invisible causes, there is much to fortify the belief that flaky test bars are ultimately due to inclusions of oxidized material at the original grain boundaries, sometimes indistinguishable from tenuity, dispersity or lack of optical differentiation, but nevertheless persisting since the metal left the furnace or introduced by subsequent overheating. As such they prevent normal adhesion at the original grain boundaries, and while no extensive burst or crack may exist in the finished piece at such areas, as soon as the surrounding metal is stressed beyond its elastic limit, these brittle planes of weakness give way first, the fracture typical of a “flake” simulating the original but now deformed coarse-crystalline boundaries. Localized stresses then extend the fracture to failure with little contraction in area, typical of “notched” bars.

On this basis, flakes are caused by faulty furnace

practice. They tend to run by heats, yet their occurrence is so variable that they are not due to any particular metallurgical practice or to any chemical composition—they are found in converter, basic and acid open-hearth and electric steels, and while giving most trouble in tender alloy steels (possibly due to their viscosity or crystalline habit) they have been found in common carbon steels when pulled transversely to the direction of working. Yet the flakiest steels have been produced on this side from the use of rusty turnings, light scrap, or excessive ore, or from stopping the boil, or casting insufficiently worked metal, and the defect has been largely eliminated by approximating the successful European practice of using only the purest materials, melted under a reducing flame, and worked with a minimum of iron ore. Whether like practice will eliminate the dangerous "gashes" and "fissures" in rail steel depends upon the moot question as to whether these defects are due to flakes in metal or to tearing the structure of excessive reduction in rolling.

Thus the higher oxides of iron trapped within the steel even in minutest particles seem to be the real culprits responsible for flakes; large quantities of a neutral slag will not cause like bad effects. As Giolitti points out, a tiny bit of oxidized material will so disturb the equilibrium existing in normal steel among ferrite, cementite and two carbonoxides that an excess of CO<sub>2</sub> will be formed, causing a local decarbonization and a thin border of ferrite on the surface of the original dendrites. This white ferrite—probably embrittled by other segregated impurities—is the plane of parting, and upon stressing produces the silvery, coarse-crystalline "flake." On such a basis it is evident that overheating before forging will cause flakes simply by the formation of "burned" spots where oxygen has penetrated into the liquid grain boundaries of otherwise sound metal. Again, flakes have formed on deep-seated carburization of what seemed to be perfect ball-races. Here an oxidized impurity caused a sharp variation in carbon concentration, and on hardening induced internal bursts by a mechanism exactly similar to that of exfoliation.

#### HOW TO ELIMINATE THE DEFECT

There yet remains to be explained, however, why there is no particular microscopic appearance associated with flakes other than a markedly non-homogeneous structure such as elongated dendrites, banded regions of excess ferrite or small grains. In other words, flakes often show no ferrite borders under the microscope, and grain refinement may exist up to the parting itself. But it should be remembered that the amount of excess ferrite induced by a tiny, almost invisible, inclusion is likely to be little more than the thinnest shell, which under proper heat treatment will quickly diffuse back into the sound metal. Heat treatment must be long continued, however, to allow slow-diffusing impurities to migrate away from their location, and to exhaust permanently the decarbonizing potentialities of a bit of oxide. Nor can it obliterate an internal crack any more than it can refine the grain of an exposed break—grain refinement occurs only up to the parting plane. In such cases the apparent crystallinity of a flake in hardened steel is a surface configuration only, but in fact persisting since the original crystallization of the ingot.

If the above analysis of the situation is correct, it is evident that the best way to eliminate flakes due either to

cracks in ingots or to included films is by careful metallurgical practice, starting with the selection of proper charge components, continuing through melting, refining and casting stages into the mechanical reduction processes and heat treatment even up to the final anneal to release hardening strains, for flakes have appeared in all these stages.

It is idle to say that Americans cannot follow European methods and use purest raw materials, or that the way to eliminate flakes in nickel steel is to leave out the nickel. Sound alloy steel of high strength can be made if every energy be turned toward quality rather than quantity—a practice Americans like to talk about but seldom think expedient to put into practice. Should flakes appear in the ingot, it is doubtless best to scrap the ingot before spending a great deal of labor to make it into a forging, then only to be rejected.

Flaking in small degree may be cured, not by cutting more and more test bars until a good one is found, but by heavy reduction to knead the original structure and long annealing to allow the complete diffusion of soluble segregates. Mechanical reduction processes at correct welding temperatures and by moderate stages are obviously the most important factor in closing permanently clean and open cracks; a practice which only makes good metal better. Flakes from segregates can best be warded off by eliminating segregating impurities; long carefully planned heat treatment is required for the correction of this defect appearing in minute amount. Therefore dirty metal should be scrapped.

Such observations appear to be truisms, and so well accepted by the metallurgical fraternity as not to warrant repetition, were it not for the fact that the occurrence of flakes at a time of national danger is only another illustration of what happens when careful metallurgical practice is disregarded. One cannot make good cannon out of bad ingots, but can easily make bad cannon out of good ingots.

#### Attorney General Interprets War Minerals Relief Act

At the request of the War Minerals Relief Commission the Attorney General has rendered an opinion interpreting Section 5 of the Relief Act which was designed to reimburse net losses sustained by persons who were "producing or preparing to produce either manganese, chrome, pyrites or tungsten in compliance with the request or demand of the Department of the Interior, the War Industries Board, the War Trade Board, the Shipping Board or the Emergency Fleet Corporation." In his opinion the Attorney General stated that "one of the five Governmental agencies must have asked (either by request or demand) the claimant to produce or to prepare to produce one of the four named minerals. The statute specifies the five agencies authorized to make request or demand for the production of minerals, specifies the minerals, and specifies that the production, or preparation for production, must have been 'in compliance with the request or demand' of one of the five agencies."

Under this interpretation it appears that those who sustained loss by producing or preparing to produce the minerals named in response to a general appeal or solicitation will not be entitled to relief under the provisions of the act.



## Manufacturing Plant of the Providence Gas Co.—III\*

Description of the Installation and Operation of a Battery of 40 Koppers Cross Regenerative, Combination, By-Products Ovens—Extension of the Coal and Coke Handling Apparatus—Treating of Coke Oven Gas

By WALTER M. RUSSELL

AS EARLY as 1914 the engineers of the Providence Gas Co. felt that the Dessau vertical coal gas plant should never be extended in case additional coal gas equipment was needed; in fact, it was even recommended that that plant be abandoned and a new plant of Woodall Duckham vertical retorts be built in its place. After having had an opportunity to study the Dessau vertical plant for several years, it appeared that American conditions were so very different from European conditions that a type of plant which had proved successful abroad might not be so in this country. In 1914 the vertical retort had not been developed in this country to the extent that it now has, particularly in the use of silica material and labor saving devices. Therefore, the abandonment of the vertical retort plant at Providence must not be taken as a condemnation of the system or even of this particular plant. In April, 1917, a report was made, recommending that a coal gas plant of 6,000,000 cu.ft. daily capacity be built. Careful study was made of the existing types of plants in the United States. At about this time, Mr. John R. Freeman was elected president of the gas company, and during the year 1917 also was appointed as the company's engineer. By the time Mr. Freeman had become president of the company, the growth of the business was such that any system other than bulk carbonization appeared unsuited for this plant, which eliminated from consideration even the highly successful vertical retort plants typified by the works in Rochester, N. Y. In November, 1917, after an exhaustive study of the whole situation, Mr. Freeman brought in a report, recommending the construction of a Koppers combination gas oven plant with a nominal capacity of 700 tons of coal a day, and this plan was adopted.

### COMBINATION GAS AND COKE OVEN DECIDED ON

Installations of Koppers ovens at St. Louis, Mo., and the Seaboard By-Product Coke Co., Jersey City, N. J., had been serving their respective cities with a part of the gas from the carbonized coal and had demonstrated the feasibility and value of such an operation. It was considered impossible, in the case of Providence, to operate a straight coke oven plant successfully, as the volume of coke for sale per thousand cu.ft. of gas sold appeared to be excessive. In the other installation of Koppers ovens, where the gas was used for city purposes, it was the rich portion of the gas which was so distributed, the lean portion being used to heat the ovens. The first intention was to build ovens at Providence which could be operated only as producer gas fired ovens, but later this plan was changed and it was decided to build a combination gas and coke oven

which could be operated either as a gas oven or coke oven. A single collecting main only was supplied. Therefore, all of the coal gas, both the rich and the lean, is mixed at the collecting main and delivered through the plant to the storage holder. Gas can be taken from the storage holder and returned to the battery, being burned in the flues by means of the ordinary gas burners supplied with standard Koppers combination ovens. Also the ovens can be operated on producer gas. One of the reasons why this decision was arrived at was that it was intended to build a by-product producer gas plant and there were certain possibilities connected with starting up such an installation which made it advisable to have the alternative feature as a matter of safety and insurance for continuity of operation.

Also should the market for coke ever become capable of absorbing at a sufficiently high figure the entire output of the battery operating on its own gas, the water gas plant could make up the deficiency of coal gas output thereby occasioned.

### DESIGN ALMOST ENTIRELY NEW

As there were no Koppers ovens operating in the United States on producer gas, it was necessary for the Koppers company to make a comparatively complete new design, particularly with reference to that part of the oven below the sole flue, including the regenerators, producer gas and fuel gas mains and passages and the apparatus for their control. Thus, this battery of ovens as it stands to-day represents something entirely distinct from any other plant yet built in the United States, but it has already demonstrated its value and justified the faith of the builders, and it will undoubtedly prove the forerunner of a series of such installations.

It was at first intended to erect a battery of producers to operate on coke breeze and small coke. These producers would probably have been of the well known Kerpely type, which has proved so successful in foreign Koppers oven installations. The writer first became associated with this project in the latter part of 1917 and brought to the attention of the company's engineers the great possibilities of the bituminous coal producer, particularly when operated on by-product recovery, citing the well known examples of such practice in England. A careful investigation of the possibilities of bituminous and by-product producers was undertaken and, after a long series of experiments, investigations and consultation with the foremost gas producer builders and producer gas engineers in the United States, a contract was finally given to the Wellman-Seaver-Morgan Co. for five producers and to the Steere Engineering Co. for the equipment for cleaning, cooling and preparing the gas for use in the ovens.

\*This is the third and last part of a paper read before the American Institute of Chemical Engineers, at Cambridge, Mass., June 20, 1919. See CHEMICAL & METALLURGICAL ENGINEERING, Vol. 21, Nos. 1 and 2, pp. 34 and 88.

The Wellman-Seaver-Morgan Co.'s engineers brought out an entirely new design of gas producer intended to operate on bituminous coal, either with by-product recovery or without, depending on the depth of fuel bed and other special details. The Steere Engineering Co. proposed a gas cleaning plant similar in many details to plants which it had already put in successful operation and also including some new and novel conceptions.

Owing to changes which were made by the gas company in its plans late in 1918, it was not possible to complete the producer gas plant in time for it to be used for the first few weeks' operation of the ovens, and they were therefore started up and run for a few weeks on run of oven gas; thus demonstrating their flexibility and adaptability to widely different conditions of operation and fully justifying the expenditure for including the combination feature.

Patriotic conditions played no small part in forming the decision to adopt a coke oven plant. At the time



FIG. 20. COAL BELTS ALONGSIDE COAL DOCK AND REHANDLING PLANT

the contract was let, the United States Government was experiencing a severe shortage of foundry coke and lent considerable assistance toward the construction of this plant, with a view to taking over its entire output of coke immediately on its completion. The uses of the War Department would also have provided an outlet for its production of aqua ammonia from the coke oven gas, sulphate of ammonia from the by-product producer plant and the light oil products from the benzol plant. As the plant did not begin to turn out coke until January, 1919, the demands of the Government no longer existed and other outlets for its products are being found.

#### MINOR ADDITIONS TO THE WORKS

In addition to the building of a battery of ovens and the extension of the coal and coke handling apparatus and the apparatus for treating the coke oven gas, many other improvements to the plant had to be undertaken during the past year, which included the erection of a coal store for boiler coal, an administration building, a stocking or rehandling pit for railway coal, the installation of four Coxo stokers for handling inferior grades of boiler fuel, the installation of a new feed water heater and the construction of a storage battery plant to provide power for peak load demands, in addition to the regular output of the works' private power plant.

These minor additions to the works' equipment will be discussed before the description of the oven plant proper, as they were in a sense preliminary to it.

**Stocking and Rehandling Pit**—In years past, almost all fuel for the gas was received by boat, but disturbed transportation conditions during the year 1918 caused a great deal of all-rail coal to be brought in. Ordinarily this all-rail coal could be handled direct from the cars by means of the telfer buckets, but the above-mentioned unusual conditions made this impossible. A concrete pit was, therefore, constructed at a convenient place under the telfer lines, so that two cars of coal could be discharged by means of hopper bottoms or side dump chutes onto an inclined plane, which carried the coal into a pit directly under the telfer rail, where one or more telfer buckets could readily obtain access to it. This pit has been in constant use during the past year.

**Administration Building**—The development of the manufacturing department and the unusual amount of repair work during the past year for rehabilitating the plant required more extensive shops and offices than existed. In addition plans were in process of formulation for the development of by-product business and for very careful chemical control of the plant. When the Sassafras Point Works was first built, a portion of the meter house was used as an office and works laboratory, but this was entirely inadequate for the past year and was also situated at a considerable distance from the heart of the works.

It was, therefore, decided to remodel an existing building, the foundations and roof of which lent themselves to such a project. A brick building was, therefore, constructed, containing basement, first and second floors, which is 144 ft. long and 40 ft. wide with an ell 31 ft. wide and 144 ft. long. The basement contains a shop for the repair of automobiles, ample storage room for heavy machinery and parts and very complete lavatories and locker rooms for the shop and office employees. On the ground floor are the superintendents' and engineers' offices and a well equipped machine shop, forge shop and carpenter shop. On the second floor are several large rooms which are now unoccupied but which will later be used for the service of the distribution department. On this floor there is also an instrument room for the storage and care of all sorts of instruments used about the works, library and museum, main chemical laboratory, photographic dark room, photometrical laboratory, coal grinding and sample room, mechanical drafting room and construction engineers' offices.

All parts of the works are connected with the administration offices by means of an intercommunicating Select-O-Phone system.

**Coal Handling**—A receiving hopper was constructed on the coal bridge to work in connection with a 36-in. belt feeder conveyor. Coal dropped into this conveyor is delivered to conveyors running alongside the coal pile. There are two of these conveyors, serving nearly entire length of the coal pile, some 460 ft., the transfer station being located near the middle of the coal storage space. (Fig. 20.) These 30-in. belt conveyors carry traveling chutes, which take the coal from the feeder conveyor on the bridge. The longitudinal belts deliver to a 30-in. belt conveyor, which takes the coal from the transfer tower to the top of the coal mixing and crushing house. The conveying machinery for coal and coke was furnished by the Robins Conveying Belt Co.

The mixing and crushing building is of reinforced concrete construction with red brick panels and contains a Bradford breaker, two mixing bins, each of 100 net tons coal capacity, a refuse bin of 50 tons coal capacity,



a coal mixer and a hammer mill with the necessary electric motors and accessories for the operation of the coal machinery. The outside of the bin walls are faced with common red brick. Steel sash window frames and steel doors are provided. The coal bins are lined with reinforced glass.

The coal coming up from the transfer station is delivered to a 12-ft. x 14-ft. Bradford breaker, where the

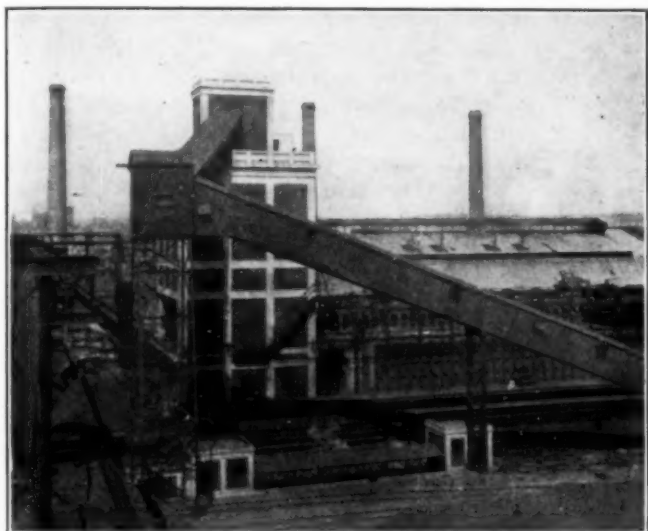


FIG. 21. COAL BIN, OVENS AND CONVEYORS. COKE WHARF IN FOREGROUND

coal is broken to approximately 1½-in. size, dropping into either of the two bins. One bin is used for high volatile and one bin for low volatile coal. The coal drops from the bins through two chutes onto two coal mixing belts, where the coal is mixed, passing thence into a hammer mill or crusher with a capacity of 100 net tons per hour. This hammer mill may be by-passed, if it is not desired to pulverize the coal. The crusher and Bradford breaker were furnished by the Pennsylvania Crusher Co.

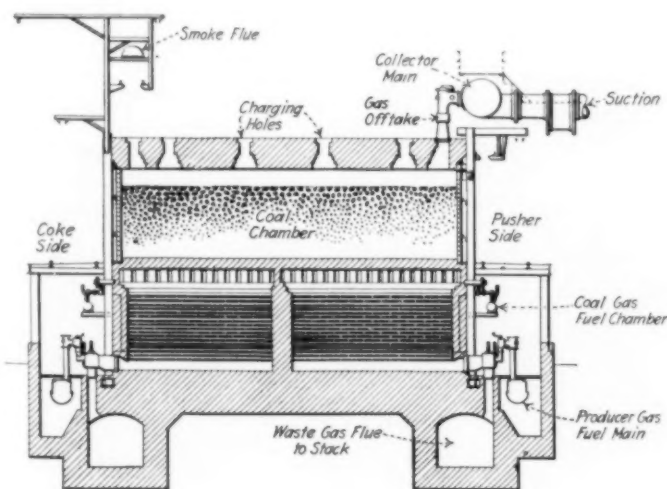


FIG. 22. SECTION THROUGH REGENERATORS AND OVEN

From the hammer mill or the by-pass, the coal drops onto a 24-in. belt conveyor, which delivers the coal to a transfer tower, thence onto another 24-in. belt conveyor to the top of the coal storage bin.

The coal storage bin is built of reinforced concrete and has a capacity of 750 net tons of crushed coal. It has steel sash window frames with double strength glass

and steel doors. The hoppers in the bin are lined with glass, and in the bottom of the bin are twelve hoppers arranged in three rows of four, each hopper being provided with a cast iron duplex gate for charging coal into the larry car. The bin is divided into two parts by a partition, so that two kinds of coal may be in storage at the same time, such as straight high volatile or high and low volatile mixture of any desired proportion. The panels on the building are filled with common red brick. A stairway is provided for access to the various parts of the building. (Fig. 21.)

When using a mixture of high and low volatile coal for making foundry coke or hard grades of domestic coke, the hammer mill or crusher is used and the coal is delivered to the coal bin pulverized so that from 80 to 85 per cent will pass a ½-in. mesh screen.

When using the straight high volatile coal, it is sometimes desirable to have much coarser coal, and the hammer mill is then by-passed. The capacity of the coal handling equipment is such that 700 tons, or a full day's run, of coal may be put through the plant and into the storage bins in ten hours. It is apparent that should the capacity of the plant be doubled at any future time, the coal handling equipment is sufficient to care for this increase.

**Oven Battery**—There are forty Koppers patented, cross-regenerative, combination, by-product coke ovens built in one battery, resting on a reinforced concrete pad, with reinforced pinion walls at each end. The ovens have a capacity of 11.4 net tons each and are 37 ft. long from face to face of doors, 9 ft. 10 in. high, 15½ in. wide at the narrow end and 18½ in. wide at the wide end. The ovens are 3 ft. 6½ in. from center to center. All oven brick work exposed to high temperature is silica, the secondary portions being firebrick. Common brick is used to face the regenerators and as fill above the ovens, and the tops of the ovens are covered with paving brick.

The ovens are designed to be operated either as

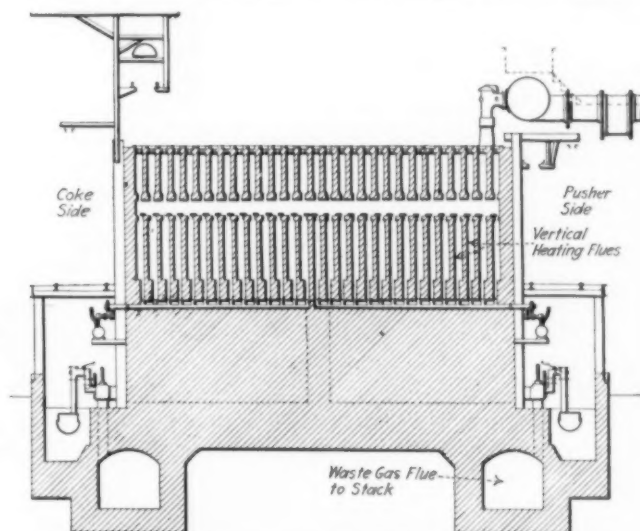


FIG. 23. SECTION THROUGH OVEN HEATING FLUES

coke ovens, using part of the run of oven gas in the heating flues, or as gas ovens, using producer gas generated in an independent producer plant from coal or coke, and are designed for a 15-hr. coking time. Under each oven is a double generator, the walls between the double regenerators being built under the vertical heating flues and being very heavy and tight. Length-

wise through the center of the regenerator runs a light division wall. There are two lines of ports entering each flue chamber, one from each of the adjoining regenerators.

One double regenerator is entirely given over to the preheating of the air for combustion, the air from one side of the central division wall going to one set of flues and that from the other side to the next set of flues. The next adjacent double regenerator preheats

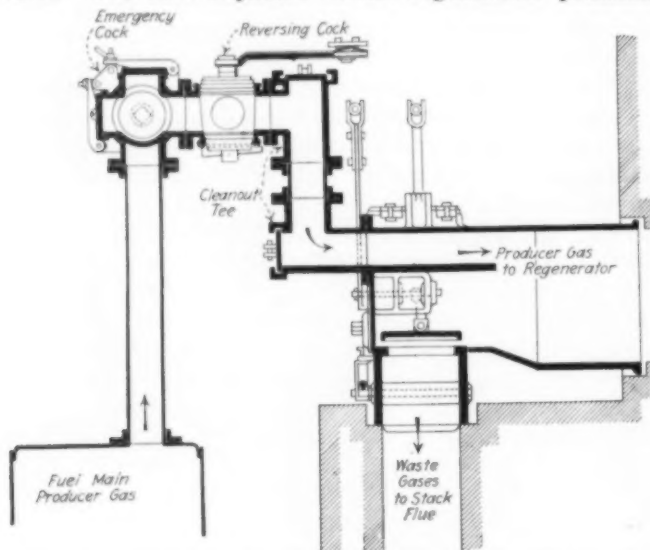


FIG. 24. CROSS-SECTION THROUGH PRODUCER MAIN

the producer gas and distributes it in a similar manner, the gas from one side of the central division wall going to one side of the oven and from the other half going to the other side. Thus, any leakage through the narrow division wall is of no importance, as air and gas are separated by the heavy walls under the flues. (Fig. 22.)

When using run of oven gas, the divided regenerators are used for air only. The oven is supplied through a fuel gas main feeding risers which serve the gas ducts just under the flues. This duct is divided into two parts, each serving approximately one-half the oven flues from opposite sides of the battery. At the base of each flue is a removable nozzle, through which the burning gas issues. (Fig. 23.) Combustion is regulated by means of a system of sliding bricks acting as dampers on the vertical flues as they lead into a horizontal flue. Each flue may be regulated independently. Also dampers are provided to regulate the draft in each regenerator outlet. The gas burns in one-half of the flues at a time at one side of the battery, the products of combustion rising to the horizontal flue, passing to the other half of the battery, down through the vertical flue to the regenerators, to the main flue, to the stack. Thus, the regenerators are reheated by the products of combustion on alternate sides of the battery.

The direction of the flow of the oven or producer gas is reversed automatically through the system of burners, flues and regenerators every thirty minutes. Thus, the regenerators return to the flues a large amount of heat which would otherwise be wasted.

The nozzle through which run of oven gas burns is located midway between two rectangular ports, each serving one-half of a generator. When using oven gas, it is not advisable to supply air for combustion to each nozzle from both sides; so it is considered good practice

to close with a brick one of these openings, allowing the air from only one opening to mingle with the gas for combustion. The next adjacent gas nozzle is served with air from the opposite side; so that the placing of the bricks closing off the air ports from the regenerators is in a sort of staggered formation. On the other hand, when the producer gas is used, the gas nozzles play no part and are closed and the bricks covering the alternate regenerator ports are removed, and in any given heating flue, one line of ports feeds gas from one-half of a double regenerator and the other line of ports feeds air from the regenerators.

Draft for the ovens is provided by a red radial brick stack 7 ft. 6 in. inside diameter and 200 ft. high. There is a main stack damper, a regulating damper for each flue, serving the two sides of the battery, and a system of reversing valves and dampers. The reversing is done automatically. A time clock, which may be adjusted for any given reversing period, actuates contact devices, which set in motion electric motors, which, in turn, operate the various apparatus concerned with reversal.

When run of oven gas is being used to heat the battery, the reversing machine operates the gas cocks on the run of oven gas lines, but when producer gas is being used, the cocks on the run of oven gas line remain closed all the time, and the reversing mechanism operates the valves on the producer gas lines, handles the dampers on the flues, opening one and closing the other for reversing the flow of products from one side of the battery to the other side, and also, at the proper time, opens the wind boxes which supply the air to the generators. (Fig. 24.)

The oven doors on the pusher side have a secondary leveling door at the top. All doors consist of a cast iron frame lined with firebrick. These doors on the coke side are handled by a Koppers door lifting machine operated by electric motors.

For pushing the coke out of the ovens, a combined pusher, leveler and door lifting machine is employed, carrying a ram which pushes the coke from the oven, a motor rope driven leveling bar to level the coal in the

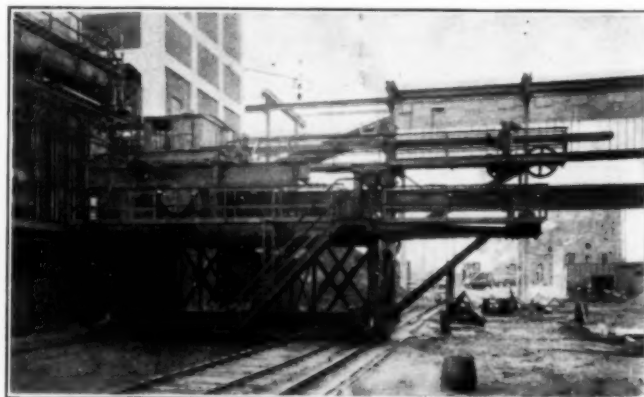


FIG. 25. COKE PUSHER AND LEVELER

ovens, a door ram to remove the oven doors and a carbon scraper. (Fig. 25.) On the coke side, there is a door machine, which handles the doors, and a coke guide, which is constructed of steel and which directs the movement of the coke across the coke bench into the quenching car. The coke is received in a coke quenching car with a capacity for one oven, which has air operated cylinders for opening the doors. (Fig. 26.) The bot-



tom of the car is lined with cast iron plates and the ends of the car with steel plate. This car is handled by a 15-ton electric locomotive. After the coke is received in the car, it is taken to the quenching station.

For charging the coal into the ovens, there is provided a coal charging larry, electrically driven, which has four coal hoppers made of  $\frac{1}{4}$ -in. steel plate. (Fig. 27.) During the charging of the oven, a sort of valve comes down on the coal hole frame, which largely prevents smoke from escaping at this point. The smoke

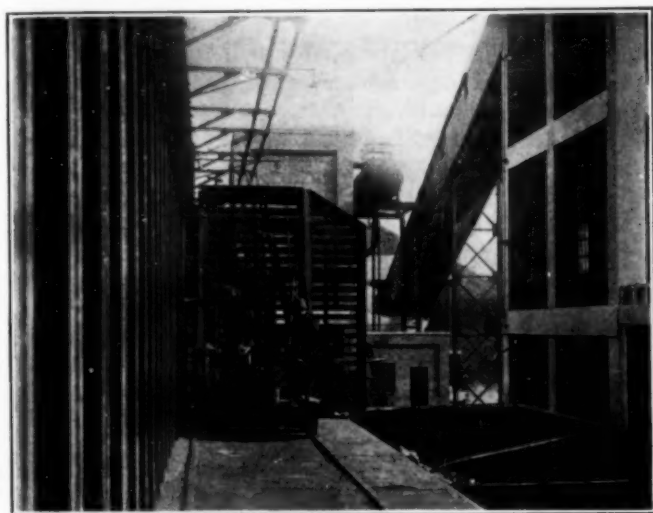


FIG. 26. MUD CAR, COKE GUIDE AND COKE QUENCHER

flue extends the entire length of the coke side of the battery and connects with the battery stack. A telescopic pipe mounted on a carriage can be used to connect the smoke offtakes of any oven to any smoke flue through a mushroom valve acting in connection with telescopic pipe mounted on a carriage. Most of the smoke generated during charging can be drawn up through this telescopic pipe into the smoke flue and thence to the stack. The operation of removing the doors, pushing the coke, replacing the doors, charging the coal, leveling same and replacing coal hole lids is accomplished very smoothly and quickly with a minimum of disturbance. Three clay carriers are provided—two on the coke side and one on the pusher side—and as fast as the oven doors are replaced they are luted with clay, which is prepared in a clay mixer located under the coal bin.

The run of oven gas, after passing through a wet meter, is brought back to the battery through a 12-in. fuel gas main, a short pipe running from this main to each gas burner, the gas burners being provided with shut-off cocks, carbon caps, etc.

From each oven a short 13-in. cast iron ascension pipe carries the gas from the ovens to the gas collecting main. In the upper section is a butterfly valve and a cleaning door, the ascension pipes entering the collecting main at one side. The collecting main serves the entire battery and is circular in cross section, 54-in. in diameter, sloping from each end to the center, at which point the offtake main connects. This main is provided with the necessary cleaning holes and is built of 3-in. steel plates with a walkway on the top. Sliding plate dampers are provided each side of the offtake main, so that one-half of the battery may be cut off at a time. The offtake main is 30 in. in diameter and is built up of riveted pipe. This main runs over to the producer house wall, supported on a steel bridge.

The gas then passes into a down-comer, which is built of two vertical cylinders, one telescoping the other, the outer portion being 4 ft. 4 in. in diameter and 10 ft. long, with a conical bottom, dipping into a seal tank. The inner portion is 30 in. in diameter and 8 ft. 9 in. long. The condensates from the gas and flushing liquor pass down through the down-comer, into the pitch trap and seal tank. The gas passes from the inner pipe to the opening at the top of the larger portion, thence through 30-in. riveted pipe from the top of the down-comer to the ground, then underground to the by-product house. A circulating tank 15 ft. diameter and 9 ft. high built of steel plate with a partition is located at the yard level, this tank being used for supplying tar and liquor for flushing purposes.

**Coke Handling**—The coke, which is received in the quenching car, is carried to the quenching station, which consists of a quenching and settling basin and a quenching tank. The hood is 20 ft. wide and 50 ft. long and has a total height of 60 ft., being built of brick, open at one end only, so that the quenching car can enter. The water tank is of steel and has a capacity of 7500 gal., being supported overhead on a steel framework about 60 ft. from the ground. A stray pipe is located under the quenching hood. Two motor driven pumps are provided for handling the quenching water, which is recirculated from the sump through the settling basin, etc. The sprays have quick-opening valves and discharge the contents of the tank in 35 to 60 seconds. The coke car, after having received the charge of quenching water, is drawn out from the hood and allowed to stand for a few minutes for draining, the drained water running back into the sump. A small amount of makeup water is required each day to take the place of steam driven off. The quenching hood being some 60 ft. in height throws the rush of steam and vapor high above the yard level. After standing the necessary time, the coke is drawn along the coke road to the

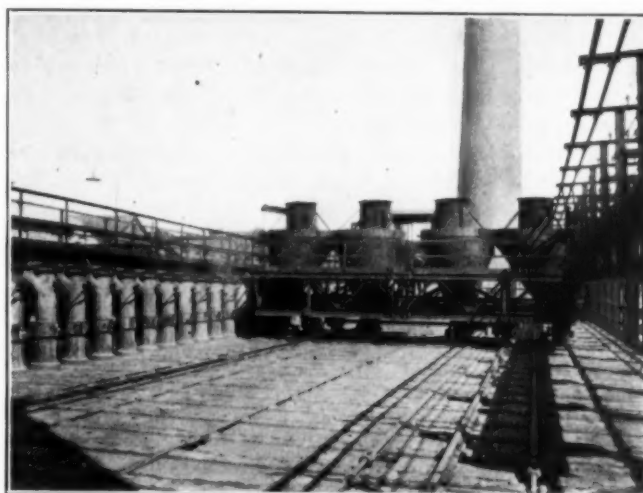


FIG. 27. LARRY CAR AND TOP OF OVENS

coke wharf, which is at the opposite end of the battery from the quenching station. This coke wharf is 48 ft. long and is built of reinforced concrete with cast iron plates and is provided with finger gates and feeders. The coke is fed onto a 36-in. belt conveyor, with a capacity of 40 tons per hour, which runs alongside the coke wharf, then rises to the foundry screening station. The foundry screening station is built of reinforced concrete with red brick panels. The run of oven coke is delivered by the belt conveyor to a rotary grizzly, from

which a 36-in. shuttle belt conveyor delivers the foundry coke to open top coke cars on a railroad track alongside. The smaller sizes of coke dropping through the grizzly fall onto a belt conveyor, which ascends to a transfer station, then transferring to another ascending belt rises to the elevation of the telfer lines, passing along under the telfer lines.

Under the telfer lines is a system of rotary grizzlies, which may be operated in several ways. The egg, stove, nut, pea and breeze coke come first to a rotary grizzly, which takes out the egg and drops it into a bay underneath the telfer lines, whence it can be rehandled. The coke then passes to a second set of grizzlies, which take out the stove size, which likewise falls into its proper bay. The nut, pea and breeze then go on a belt to a pit or bin adjacent to the screen houses, where they are, in turn, deposited. From this pit either one of two telfers can pick them up and send them to either of two shaker screen houses, where they are separated into their respective sizes.

Likewise, should the storage piles be full, or if, for any other reason, it is undesirable to separate the egg and stove on the rotary grizzlies, these can be by-passed and all sizes go to the pit, whence they are sent through the shaker screen houses.

#### FLEXIBILITY OF THE SYSTEM

This makes a very flexible arrangement, so that if the shaker screen houses are down for any reason, the production of egg or stove size is not stopped, as the rotary grizzlies can take care of this; also should the egg and stove piles be well filled under the rotary grizzlies, the shaker screen houses can be called upon to make all five sizes of coke.

In addition to the above arrangement, when foundry coke is not being made or if it is desired to send run of oven coke direct to railroad cars, plates may be put on the grizzly; so that all the coke will drop onto the shuttle belt which goes to the cars. If it is desired to make all domestic coke and no foundry, the foundry grizzly is run, but the large sizes which go over this grizzly and drop onto the shuttle belt are carried to a coke crusher. By reversing the direction of this shuttle belt, this coke crusher breaks the large sizes into domestic sizes, which, dropping through the crusher, are caught on the same belt which is handling those sizes of coke which fell through the foundry grizzly, and thus the whole output of coke in domestic sizes is carried up to the rotary grizzlies under the telfer lines, where the egg and stove are prepared, and also, by the shaker houses, the nut, pea and breeze sizes of coke.

It will be noted that great care has been taken in arranging the coke handling system to avoid tie-ups due to any particular set of conditions, and it is believed that this arrangement will take care of the entire output of coke from the ovens without further additions for some time to come.

The run of oven coke carried by the belt to the foundry screen house is automatically weighed by a Merrick weightometer, so that an accurate weight is obtained on the yield of coke from the coal daily.

After the coke is passed through the shaking screen stations, it drops into bins, from which it can be chuted directly into trucks or wagons or handled into cars, trucks or wagons by the telfers.

A large amount of coke is also handled in paper

bags and canvas bags. Small size coke for domestic use is delivered in canvas bags, which are filled in the screening station and placed on a roller conveyor, which automatically transfers them to a wagon loading house, which is 90 ft. long and 29 ft. wide and which will provide ample storage for bags and from which as many as sixteen teams may be loaded at one time. In all as many as forty teams and trucks can be loaded with bag and bulk coke in different parts of the yard, which is considered ample for the domestic trade that is anticipated.

For loading foundry coke, one shuttle belt loader combined with a box car loader will take care of one car to be loaded as the coke is made. Locomotive cranes can also load from storage piles. On the north side of the producer house is a set of track hoppers served by the telfer lines, from which coke may be loaded into four cars at a time for railroad shipment. In addition to this, it is planned to put bins for loading at least two cars under the telfer lines in other parts of the yard, so that in all, including foundry coke and domestic sizes, as many as eight railway cars of 30 to 40 tons capacity can be loaded at any given time.

*Condensing and Deammoniating Plant*—The condensing plant built by the Bartlett Hayward Co. for handling the 3,000,000 cu.ft. of retort gas consisted of water tube condensers, P. & A. tar extractors and rotary scrubbers. This equipment has been utilized exactly as it stood with the exception of a few minor changes in the movement of scrubber water, liquor, etc. A new exhaustor was added, making three in all. Two are used, with the third as a spare. There was ample room in the building for the addition of this third exhaustor.

It became necessary to provide gas treating apparatus for 4,000,000 cu.ft. of gas to take care of the total of 7,000,000 which it was contemplated the new coke ovens would produce. Various systems were considered. Had the conditions in the industrial world been normal and the prices such as to make the investment reasonable, it is probable that a complete new by-product plant would have been built, probably of the Koppers system, but funds were not available for such a development at the time and it was felt that the extension of this part of the plant must be made as economically as possible. The Steere Engineering Co. of Detroit had in the past few years developed a system of handling gas for condensing and deammoniating, which had previously attracted the writer's attention and which appeared to be a possible solution of the present problem. The engineers of the Steere Engineering Co. were invited to study the local situation and prepare plans for condensing and deammoniating equipment, which were duly completed and submitted and, with some slight changes, accepted by the company. The gas coming from the ovens in an underground main divides between the old primary condensers and the new Doherty washer cooler as designed by the Steere Engineering Co.

This washer cooler consists of a steel plate shell 5 ft. in diameter and 29 ft. high, packed with wooden grids after the manner of the tar scrubber. Over these grids liquor is circulated by means of electrically driven centrifugal pumps. The gas then passes through the exhaustors and tar extractors and again divides, the proper proportion going to a secondary washer cooler, where the temperature is brought down as low as 60



deg. F. if desired. The wash liquor which is pumped over the grids in the washer cooler goes from the base of the coolers through a series of cooling coils, which are set up in a convenient location adjoining the building. Cold water runs down over these cooling coils from suitable troughs and the cooling of the recirculating wash liquor is thereby quickly and economically effected by means of direct contact between the cold incoming wash liquor and the gas. Very complete transfer of heat is secured and the heat potential is much less than with multitubular water condensers.

#### SATISFACTORY WORK BY WASHER COOLERS

The operation of these washer coolers is highly satisfactory. The condensed liquor and tar from them forms a surplus, which overflows from the base of the scrubbers through a seal to the main tar liquor separators for the ammonia storage wells. After leaving the secondary washer coolers, the streams of gas again come together and pass through the old Feld washer, thence through the two rotary scrubbers and finally through the intensive scrubber supplied by the Steere Engineering Co. This intensive scrubber is 15 ft. long, 6 ft. 6 in. wide and 22 ft. high and contains four compartments filled with wooden grids, over which the wash liquor is circulated by means of four motor driven centrifugal pumps. Fresh water is admitted to the last compartment and the wash liquor is recirculated in this compartment, then passing progressively through each of the other three compartments, finally discharging to a tank in the condenser house, underneath one of the rotary scrubbers. From this tank the liquor is picked up and recirculated through the two rotary scrubbers, the effluent discharging into a second tank located underneath the other rotary scrubber. From this tank liquor is picked up by a steam pump and recirculated through the Feld washer, the final affluent discharging into the main ammonia storage well.

This system of recirculation of the ammonia liquor results in scrubbing out considerable portions of hydrogen sulphide and carbon dioxide in combination with the ammonia gas and is remarkably efficient in recovery of ammonia. Tests show that when using  $1\frac{1}{2}$  gal. of water to a thousand cu.ft. of gas, not more than one grain of ammonia per 100 cu.ft. of gas is lost at the outlet of the intensive scrubber. The liquor through the entire plant, including suction main, condensers, washers and scrubbers, may be made of any desired strength between 1 and 2 per cent by varying the amount of fresh water entering the intensive scrubber. Although the washer cooler and the intensive scrubber appear very small in size for the work which they have been called upon to do, careful tests show that they are amply large and since starting up have worked with great satisfaction.

#### Molybdenum Steel in the U. S.

During the past 18 months about 50,000 tons of molybdenum steel has been made in this country with very encouraging results, and it is now understood that some of the leading alloy steel makers believe that steel containing a relatively small quantity of molybdenum is superior to any other known material for high-grade aeroplane parts, such as crank shafts. The other alloying metals making up the steels are variously reported as nickel, vanadium and chromium.

## Cementing Jamb Joints

IN THE operation of the 40 Koppers coke ovens recently installed by the Providence Gas Co., the method used to seal effectively the joint between fire clay and silica brick construction, where the tenth<sup>1</sup> in. per ft. difference in expansion ordinarily would disrupt the joint and cause leakage, may have wide applicability. The size of each coking section is 40 ft. by 17 in. and the time required for coking approximately 15 hours.

Where brick work was subjected to highest temperature the finest grade silica brick was used. For face, top and checker brick, as well as oven floor, fire clay brick was employed. At the junction point between the silica and fire clay brick the difference in coefficient of expansion of the brick requires the use of cement which will seal the slip joint firmly

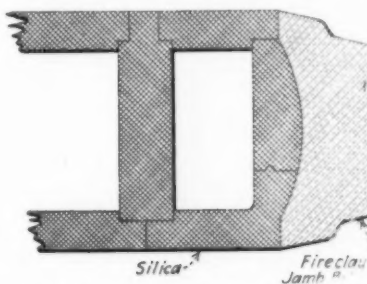


FIG. 1. SLIP JOINT JUNCTION

and prevent leakage. Diagram of this joint is shown in Fig. 1.

After trying several mixtures it was found that the best results were obtained by the use of hytempite, a high temperature refractory cement furnished by the Quigley Furnace Specialties Co., Inc., of New York.

A spraying device as shown in Fig. 2, being a modi-

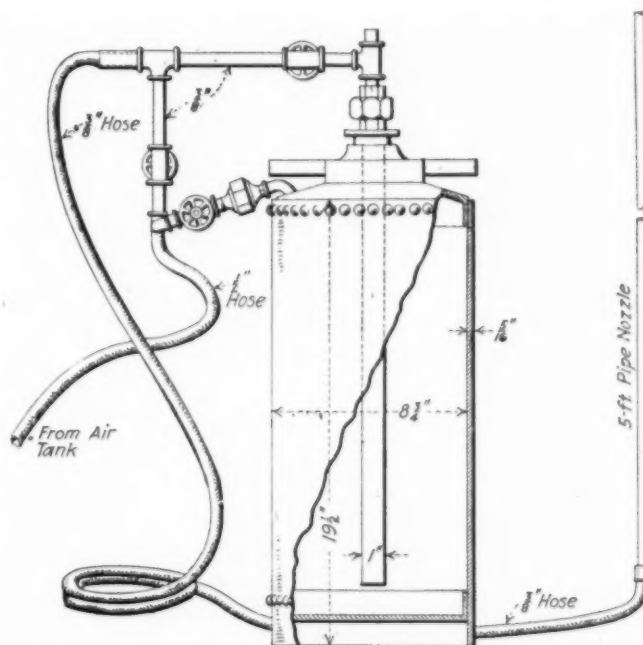


FIG. 2. APPARATUS FOR SPRAYING DILUTE HYTEMPITE INTO THE JAMB CRACK

fied type of paint sprayer made by the Spray Engineering Co. of Boston, is employed using hytempite as follows:

Dissolve hytempite in warm water in the proportion of 1 pail of hytempite to approximately  $\frac{1}{4}$  pail of warm water. Stir and mix well. Pass through  $\frac{1}{16}$ -in. wire mesh into the container used for blowing solution into the jamb crack.

<sup>1</sup>Fire clay brick, 0.075 in. per ft.; silica brick, 0.175 in. per ft. at 2200 deg. F =  $\Delta$  0.1 in. ft.



FIG. 3. DETAIL SHOWING SPRAYING JOINT WITH HYTEMPITE

Clean face of jamb bricks thoroughly, also clean the rougher material from jamb crack, with the steel tool provided for that purpose. Then apply full air pressure, approximately 50 lb., through the pipe used for patching, cleaning crack thoroughly before applying the so-



FIG. 4. FINISHING OFF WITH TROWEL

lution of hytempite. Then turn air into the hytempite container, being careful not to use too much air pressure, open proper valves and apply solution to the crack by means of the pipe and hose which are provided. See Fig. 3.

After the crack has been filled with the solution, if any portion of it remains open, smooth over with neat hytempite, using long handled trowel. By using a corrugated shield as shown in Fig. 4 the operator is enabled to carry on repairs while ovens are hot.

## Mining and Metallurgical Situation in Belgium in 1919

THE first official data on the situation of the Belgian industries at the beginning of 1919 have just reached this country. The latest issue of the *Annales des Mines de Belgique* received here contains a report of the investigation instituted by the Belgian Department of Industry and Labor on some mining and metallurgical industries.<sup>1</sup> The following is a short abstract of this report:

### COAL MINING

It can be said that of all the Belgian industries this is the one which has suffered the least from wanton destruction. This is explained not by the thought that the Germans had any consideration for the Belgians and their coal industry, but by the fact that during the first four years of the war they treated the coal mines as theirs, and only the lack of time during the last few months of the war saved the Belgian mines from the fate of the mines in northern France.

The mining situation is best shown by Table I, which gives the production for 1913 to 1918 by coal districts and totals.

TABLE I—COAL PRODUCTION IN BELGIUM, METRIC TONS

Year	Mons	Centre	Charleroi	Namur	Liège	Total
1913.....	4,406,550	3,454,640	8,148,020	829,900	5,998,480	22,841,590
1914.....	3,578,840	2,701,550	5,764,410	534,180	4,135,070	16,714,050
1915.....	3,310,200	2,573,430	3,875,690	410,660	4,007,520	14,177,500
1916.....	3,705,540	3,212,860	5,223,970	497,150	4,223,350	16,862,870
1917.....	3,869,680	2,785,400	4,671,240	437,870	3,155,510	14,919,700
1918.....	3,281,720	2,559,610	4,493,630	374,440	3,112,530	13,821,930

In the new coal district of Campine, which was ready to start actual mining Aug. 4, 1914, and from which the Belgians reasonably expected to get the needed additional fuel, the total mining amounted to 11,640 tons in 1917 and 65,670 tons in 1918.

### COKE

Of the Belgian coke ovens it is stated: Some have been in operation without the needed repairs, some have been totally destroyed (especially those of the Cockerill plants) and the remainder have been totally dismantled, and the installations for by-product recovery carried away or destroyed.

The results of this policy are shown in Table II, which gives the production, 1913-18, by provinces and totals.

TABLE II—COKE PRODUCTION IN BELGIUM, METRIC TONS

Year	Hainaut	Liège	Other Provinces	Total
1913.....	2,220,180	877,130	445,690	3,523,000
1914.....	1,406,460	595,210	?	2,001,670
1915.....	424,460	90,140	?	514,600
1916.....	667,530	124,820	?	792,350
1917.....	648,210	27,830	?	676,040
1918.....	509,150	13,060	?	522,210

### IRON AND STEEL INDUSTRY

This industry has suffered more than any other. Were it not for the figures given in Table IV, it would be difficult to realize the fate which has befallen the industry which was the pride of the Belgians. The list of examples of destruction includes every district in every province, and the once well-known skilled Belgian metallurgist is forced to labor—not only for the present, but for many years to come—with pick and shovel, in order to clear away the ruins and rebuild the plants.

<sup>1</sup>La situation des Industries en Belgique, en février 1919, après les dévastations, allemandes. *Annales des Mines de Belgique*, 2ème livraison, Tome XX, 1919, pp. 695-711.



TABLE III—IRON AND STEEL PRODUCTION IN BELGIUM, METRIC TONS

Year	Hainaut	Liège	Namur	Other Provinces	Total
1913.....	1,189,650	896,360	31,030	107,020	2,224,060
1914.....	641,560	519,860	14,870	62,490	1,547,410
1915.....	76,590	85,580	.....	2,200	164,370
1916.....	130,945	90,260	.....	2,130	200,821
1917.....	.....	.....	.....	.....	.....
1918.....	.....	.....	.....	.....	.....

## BRIQUETTES

The Belgian railways use briquetted fuel exclusively, which accounts for the fact that the briquetting plants were in most cases unharmed.

Table IV gives the production for 1913 to 1917 by provinces and totals.

TABLE IV—BRIQUETTE PRODUCTION IN BELGIUM, METRIC TONS

Year	Hainaut	Namur	Liège	Other Provinces	Total
1913.....	1,864,200	171,010	453,350	120,000	2,608,640
1914.....	1,371,480	128,730	299,490	?	1,799,700
1915.....	968,470	135,220	386,410	?	1,409,100
1916.....	1,300,850	166,710	468,260	?	1,935,820
1917.....	707,690	70,130	204,110	?	981,930

## ZINC AND LEAD

The place occupied by Belgium in these industries about five years ago is well known, but today Table V shows what premeditated destruction can accomplish.

TABLE V—ZINC AND LEAD PRODUCTION IN BELGIUM, METRIC TONS

Year	Zinc		Lead
	Ingot	Rolled	
1913.....	204,220	51,490	103,480
1914.....	145,925	30,780	70,980
1915.....	51,660	21,350	16,770
1916.....	22,930	8,045	15,560
1917.....	10,290	1,675	22,745
1918.....	.....	.....	.....

The report contains, among other examples of destruction, the case of the plants of the Dumont Frères Co. of Sclaigneaux (near Liège). These plants, especially the lead plants, which had been thoroughly modernized shortly before the war, have been completely dismantled, and all the machinery and even the roof trusses have been shipped away.

The grim comparative statement is made that the metallurgical plants of Hoboken (near Antwerp) and Overpelt, which are owned by German capital, are now in just as good working condition as ever.

## Synopsis of Recent Chemical and Metallurgical Literature

**Present American Acid Bessemer Process**—RICHARD S. McCAFFERY, professor of metallurgy, University of Wisconsin, published in the January issue of the *Wisconsin Engineer* a paper presenting his conclusions on the reversibility of manganese oxidation. He starts from a consideration of the data given in Table I.

With a gradually increasing heat, manganese carbide burns to MnO and CO<sub>2</sub>. However, if hot-pig or high-silicon iron is blown, the temperature runs up so rapidly that MnC<sub>2</sub> is retained in the bath to the end since under these conditions this compound will produce CO rather than CO<sub>2</sub>. Any manganese carbide retained acts as a powerful reducer, returning silicon to the bath, and re-

ducing Fe<sub>2</sub>O<sub>3</sub> to FeO, forming a more basic, infusible slag containing ferrites, which is largely responsible for the excessive spitting of a hot blow. Under these circumstances there appears to be residual manganese in the steel, not on account of the reversibility of the reaction  $2\text{Mn} + \text{O}_2 \rightleftharpoons 2\text{MnO}$ , but on account of the fact that the carbide is residual. In this case silicon is always residual as well. (Of course when it is said that

TABLE I

Substance	Formula	Oxidation Products	Calories per Gram Atom of Metal
Silicide of iron.....	FeSi	Fe <sub>2</sub> O <sub>3</sub> ; SiO <sub>2</sub>	245
Carbide of manganese.....	MnC <sub>2</sub>	MnO; CO <sub>2</sub>	171
Silicide of manganese.....	Mn <sub>2</sub> Si <sub>2</sub>	MnO; SiO <sub>2</sub>	135
Carbide of iron.....	Fe <sub>3</sub> C	Fe <sub>2</sub> O <sub>3</sub> ; CO <sub>2</sub>	98
Carbide of iron.....	Fe <sub>2</sub> C	Fe <sub>2</sub> O <sub>3</sub> ; CO	75
Carbide of manganese.....	MnC <sub>2</sub>	MnO; CO	35

iron silicide burns first, it means that a number of reactions are taking place at the same time, but that this reaction predominates.)

Since it was desired to find some remedy for the excessive spitting, this could evidently be reduced by close temperature regulation. This in turn could be done by three different methods: first, by charging cold scrap—which was not always available; second, by blowing steam through the tuyeres—which was costly, and third, by increasing the number of tuyeres and reducing the air pressure. Quite often the high air pressure drove oxygen clear through the metallic bath during the carbon blow, and this unconsumed oxygen burned CO to CO<sub>2</sub> within the shell, thus increasing the temperature of the bath and the air cost. Therefore, at the author's suggestion the number of tuyeres was increased from 23 to 35, and the blast pressure dropped from 28 to 22 lb. When running on successive heats from the same mixture the modified converter reduced the blowing time from 14 min. to 10 min. 20 sec., saved 40 per cent of blowing engine power, and entirely reduced the spitting.

## Book Reviews

**OPPORTUNITIES IN CHEMISTRY.** By Ellwood Hendrick, Consulting Editor, CHEMICAL & METALLURGICAL ENGINEERING. x + 102 pages. New York: Harper & Bros.

This book is one of a series intended to aid the returned soldier in vocational rehabilitation by pointing out the possibilities afforded by different industries. While written primarily for this purpose, this little book is admirably adapted to serve as an introduction to the author's larger work, *Everyman's Chemistry*, and thus to stimulate popular interest in the study of chemistry as an important adjunct to all branches of business activity. The style is intimate and conversational, so that the reader follows with interest expositions of processes and theories which, treated in text-book fashion, would prove unattractive to the general reader.

Beginning with a short outline of certain fundamental concepts, such as elements, atoms, molecules and electrons, the reader's attention is directed in turn to the great cycle of nature, by virtue of which the sun's energy is locked up in growing vegetation; the activities of the soil—invisible to the naked eye, yet responsible for the growth of crops; the mysteries of catalysis; the chemist's tiny allies—the yeasts, molds and bacteria; the manufacture of soap and its application in the laundry business; the earth as raw material and, finally, iron and steel.

It is doubtful if anyone can read the book without feel-

ing an increased interest in chemistry, not only as a science in itself, but as an aid to the better understanding of one's own business and, to quote the author in conclusion, "After all, that is the most important part of a man's working life—that his job shall be interesting to him."

ALAN G. WIKOFF.

## Personal

MR. WARREN F. BLEECKER of Boulder, Colo., was in New York recently.

MR. R. V. COOK, recently research engineer with the Koppers Co. of Pittsburgh, has joined the sales-engineering staff of the Brecht Co., St. Louis, Mo. He will have charge of the sales and erection of the new Brecht standard oil-hydrogenating plant which has just been introduced.

MR. WILLIAM E. COREY, chairman of the Midvale Steel & Ordnance Co., has been elected a director of the Sinclair Consolidated Oil Corp.

DR. F. G. COTTRELL, chief metallurgist in the U. S. Bureau of Mines, has been named assistant director in charge of investigative and scientific work. Other changes in the Bureau are the appointment of the former chief clerk, MR. F. J. BAILEY, as assistant to Director Manning in charge of executive work, and MR. H. W. MEYER, chief clerk of the War Minerals Relief Commission, to be chief clerk of the Bureau, succeeding Mr. Bailey.

MR. ALGERNON DEL MAR, milling and flotation engineer, has opened an office at 1424 Alpha St., Los Angeles, Cal., and will conduct a business in the design and operation of milling plants.

MR. R. C. GEMMELL, general manager of the Utah Copper Co., will become assistant managing director of that company and other interests of D. C. Jackling, effective Aug. 1. Besides the Utah Copper Co., Mr. Gemmell will assist in the direction of the Nevada Consolidated Copper Co., Ray Consolidated Copper Co. and Chino Copper Co. MR. LOUIS S. CATES, at present general manager of the Ray Consolidated Copper Co., will become assistant general manager of the Utah Copper Co. on Aug. 1, with offices in Salt Lake City.

MR. C. W. HARE, director of sales, War Department, sailed for Europe July 21 with a party of 22 to ascertain European conditions for the disposal of surplus property now held by the War Department in the United States.

PROF. SAMUEL HOYT has resigned as assistant professor of metallography, University of Minnesota, Minneapolis, to accept a position as metallographist for the National Electric Lamp Association, Nela Park, Cleveland.

MR. D. S. MCAFEE, engineer of the Dorr Co., has returned from Chile.

MR. GEORGE MESTA, president of the Mesta Machine Co., Pittsburgh, has sailed for Europe on a pleasure and business trip combined, to be gone until November.

MR. LEWIS A. PARSONS has resigned from the International Nickel Co. of Canada and accepted a position on the *Mining and Scientific Press* as associate editor.

MR. WILLIAM C. POTTER, of Guggenheim Bros., is a member of the board of directors of the Mexican International Corporation, recently organized to finance new enterprises in Mexico.

MR. THOMAS T. READ, formerly associate editor of the *Mining and Scientific Press*, has joined the staff of the Bureau of Mines and will investigate the work of the Bureau in relation to public welfare.

MAJOR F. H. SCHOENFESS, lately discharged as metallurgical expert from the United States Ordnance Department, where he had charge of the specifications for the heat-treatment of all parts of various types of guns, has become associated with John H. Brewster, 30 East 47th St., New York City, American representative of the Fagersta Steel Co., Fagersta, Sweden, maker of carbon and alloy steels.

MR. W. H. STAYER, mining and metallurgical engineer, of New York City, is on a business trip to Denver and other points in the West.

DR. SAMUEL A. TUCKER, formerly professor of electrochemistry at Columbia University, who served as Major in the Chemical Warfare Service, is now chief chemist for the Chemical Foundation, Inc.

MR. C. H. VOM BAUR has resigned as vice-president of the T. W. Price Engineering Co., Woolworth Bldg., New York, and will soon establish an office for the sale of the vom Baur electric furnace.

MR. M. W. VON BERNEWITZ has resigned as assistant editor of the *Mining and Scientific Press* and has come to New York to collaborate with Walter H. Weed on the *Mines Handbook*.

MR. C. M. WELD, consulting mining engineer, has returned from war work in Washington, and resumed practice with offices at 66 Broadway, New York.

MAJOR CLARENCE J. WEST, recently in charge of the editorial department, research division, Chemical Warfare Service, has joined the staff of Arthur D. Little, Inc., Cambridge, Mass., as director of the information department. While with the Chemical Warfare Service he prepared about fifty monographs on different phases of chemical warfare, dealing particularly with war gases, smokes, incendiaries, absorbents, etc. In his new position Major West will extend the library facilities of the organization and develop a special information service on technical and scientific subjects.

## Obituary

MR. CLARENCE W. HATHAWAY, metallurgist for the last eight years for the Granite City Steel Works Branch of the National Enameling & Stamping Co., met his death by drowning while swimming with a party of friends in the Mississippi River on July 19 at Granite City, Illinois. He was born in Columbus, Ohio, in 1886, and was educated in the schools of that place and at the Ohio State University, Columbus, Ohio. He had previously been employed with the U. S. Steel Corporation at Gary, Indiana, before accepting his last position. He leaves a wife, father and mother, one brother and four sisters. Mr. Hathaway was a member of the Masons and Elks; and of the American Chemical Society, Metallurgical Society of America, and the American Ceramic Society.

## Current Market Reports

**Tuesday, July 29.**—The general rise in prices noted in the last report has continued during the past fortnight, due to an increase in both the export and the domestic demand.

**Lead:**—The price has advanced to 5.85-6.00c. for New York delivery and 5.50-5.75c. for East St. Louis shipment.

**Tin:**—London prices have advanced almost daily, Straits, spot, being now quoted at £272 per ton. The general New York quotations on Straits, spot, is 71c.; electrolytic, 99 per cent, 66½-68c. Tin ore is arriving in ever-increasing amounts. During the week of July 14-21, 1850 tons were received from Bolivia.

**Zinc:**—Spot spelter continues to advance. East St. Louis, 7.70-7.80c.; New York, 8.25c.

### OTHER METALS

Bismuth.....	lb.	\$3.10 —	.....
Cadmium.....	lb.	1.50 —	1.75
Cobalt.....	lb.	2.50 —	3.50
Magnesium.....	lb.	1.75 —	2.10
Mercury.....	75 lb.	109.00 —	.....
Nickel.....	lb.	.41 —	.45
Iridium.....	oz.	175.00 —	.....
Palladium.....	oz.	115.00 —	120.00
Platinum.....	oz.	105.00 —	110.00
Silver.....	oz.	1.07½ —	.....



**Aluminum:**—The market is reported quiet and 98-99 per cent ingots are now quoted at 33c. lb. Scrap continues to advance: Cast, 23-24c.; sheet, 24-25c.; clippings, 26-27c.

**Antimony:**—It is reported that considerable export trade to Europe has developed and the market has therefore assumed a much firmer aspect. The present quotation for spot regulus ranges from 94-94½c.

**Copper:**—The rapid rise in the copper market during the past few weeks has brought the price for spot delivery to 23½c. Buyers who have bought copper for a rise now see enough profit to let go of some of their holdings, and this has stopped the further upward movement for the time being. Quotations are: Spot and July, 23½-23¾c. August, 23¾-23½c.; September, 24c.

Copper sheets, hot-rolled.....	lb.	33.50	—
Copper sheets, cold rolled.....	lb.	35.00	—
Copper bottoms.....	lb.	41.50	—
Copper rods.....	lb.	24.75	— \$25.00
Copper wire.....	lb.	26.00	—
High brass wire and sheets.....	lb.	27.75	—
High brass rods.....	lb.	26.75	—
Low brass wire and sheets.....	lb.	30.50	—
Low brass rods.....	lb.	31.25	—
Brass tubing.....	lb.	39.00	—
Brass tubing.....	lb.	44.25	—
Seamless copper tubing.....	lb.	37.75	—
Seamless bronze tubing.....	lb.	44.25	—
Seamless brass tubing.....	lb.	36.00	—
Scrap, heavy machinery comp.....		18	— 19½
Scrap, heavy and wire.....		18½	— 19½
Scrap, light and bottoms.....		18	— 17
Scrap, heavy, cut and crucible.....		20	— 21½
Scrap brass, heavy.....		12	— 12
Scrap brass, casting.....		13½	— 14
Scrap brass, light.....		10½	— 11½
Scrap, No. 1 clean brass turnings.....		11	— 11½
Scrap, No. 1 comp. turnings.....		16	— 17

### The Iron and Steel Market

When the seasonal correction is applied to the reading given by the order books of the steel mills a very favorable showing is made of the strength of the market. July and August are normally very dull months in the steel trade, but this year the volume of domestic business is showing for July a slight gain over June. In export business this is not the case, there being somewhat less activity, but that is undoubtedly due to causes other than the season, and beyond the control of the steel trade.

The trends of steel mill activity are well shown by proportioning the ingot production, reported monthly, to an estimated capacity of 49,000,000 gross tons per annum. This gives the following percentages of activity, as averages for the months: January, 87 per cent; February, 85; March, 77; April, 65; May, 54; June, 67. The low point fell in May, which, with an average of 54 per cent for the month, must have had a low point at about the middle of the month of approximately 50 per cent. June, with a sharp increase in total production, must have had a rate of about 70 per cent at the close of the month. The rate has probably not increased materially since the first of July. The July average, when reported, will probably lie between 70 and 75 per cent.

### STEEL TRADE CONDITIONS BECOMING MORE NORMAL

Conditions affecting the steel trade have altered toward the normal by a sufficient amount to justify a long-range scrutiny to determine when and how full activity in the industry may be developed. Early in the year the tonnage turned out by the mills constituted no index to the future, as the industry seemed to be running on momentum to an extent. Just why it operated as well as it did cannot readily be explained, nor if the explanation were available would it be of particular value as a foreshadowing of what should be expected for the future. The fact that the low point in steel production fell six months after hostilities were terminated by the signing of the armistice indicates very plainly that what occurred in the fore part of the intervening six months could not be indicative of what would occur in the trade later.

Assuming that the steel industry has operated in July at a rate of producing 35,000,000 tons of ingots a year, which is 70 per cent of an estimated capacity of 49,000,000 tons, this 35,000,000 tons is equal to what may be estimated as the entire capacity in 1914, there having been a 40 per

cent increase in steel producing capacity, though hardly in steel finishing capacity, during the war. In both 1912 and 1913, easily the best pre-war years from a tonnage standpoint, ingot production was about 30,280,000 tons. Thus production in July was 16 per cent in excess of the best sustained average before the war. Exports of steel and steel manufactures, reduced to an ingot basis, represented about 3,000,000 tons a year in 1912 and 1913, and represent about 5,500,000 tons at present, and thus one has it that production of ingots for purely domestic consumption is now at about two and a quarter million tons a year, or about 8 per cent, more than in 1912-13.

### INDIVIDUAL CASES OF STEEL CONSUMPTION

With this general guide as to total tonnages, one may readily compare individual cases of consumption. The automobile industry is consuming much more steel than ever before, and so is the petroleum industry, for the lap weld departments of the pipe mills are filled with orders for practically the remainder of the year, although their orders outside the petroleum industry have been distinctly light. Dwelling house construction is, or soon will be, fully up to a normal rate. Construction work involving large projects, skyscraper hotel and office buildings, bridges, power plants and factories is far below normal, although steadily increasing. Shipbuilding is at the rate of about 500,000 tons deadweight a month, and that may prove to be the normal rate for several years, but lately shipbuilding has been largely with steel accumulated during the war as a factor of safety, so that later on the shipyards will be calling for more steel from the mills. Railroad buying is completely absent. The normal proportion of railroad consumption of steel to total steel production has usually been exaggerated, some estimates having been as high as 30 or 40 per cent. A liberal estimate seems to be 20 per cent, with a 5 per cent leeway in either direction.

From this rough sketch it is readily seen that demand has opportunity to grow from its present volume by an amount easily sufficient to take up the slack between the present 70 per cent operation and a full operation, and that without any increase in export demand.

### EXPORT DEMAND

It would be quite unsafe to count upon an increase in export demand, particularly as the export bookings in July ran below those of June. The purchasing power in foreign countries is limited and in Great Britain and on the Continent exchange rates are very unfavorable. The condition is one that the steel industry itself can do little to rectify, but one that the United States, or the American people, can and should entirely rectify. We have been expecting financially impoverished nations to buy goods from us because we have goods, ignoring the fact that when we have much more money than they we should also buy from them. As a matter of self-interest the steamship companies, desiring return hauls, will probably do much to encourage an import trade, and the divergence in exchange rates will also have a favorable influence.

There is little likelihood that steel prices will change much during the remainder of this year. It is now practically assured that there will be no declines in important commodities, with the possible exception of plates, where there is so great an excess of capacity. The market has successfully stood the test of there being a period of price cutting, in which the mills with the leanest order books bought their way into the market and then resumed quoting full prices. As to advances, there is less sentiment among steel mills in favor of making advances than there was a month ago. With a larger volume of business they are better satisfied with existing prices, which are those that became effective March 21, and they have come to realize that advanced prices, perhaps of doubtful benefit in themselves, would probably precipitate labor unrest and might easily lead to advanced wages. The advanced wages would be permanently fastened on the industry, while the advanced prices might yield at any time. Here and there an independent steel producer has advanced prices on one product or another, but these advances have not taken hold generally and are not especially popular.

## The Chemical Market

New York, July 28, 1919.

The increasing foreign demand has stiffened and stabilized the entire line of heavy chemicals. Among those most urgently sought are *sodium bichromate* (by England and South America), and *caustic soda* (by Japan and South America). In addition to this, it is reported that a number of domestic contracts have been placed for these two products, covering the balance of the year. *Sodium bichromate* is probably the strongest item on the list, having advanced 37 per cent since last writing, present price being 11-12c. Not long ago it was selling below cost.

*Caustic soda* continues to mount, under the guidance of the United States Alkali Association, which has just boosted the export price from \$3.30 up to \$3.50 per cwt., f.a.s., New York. *Muriatic acid* has risen  $\frac{1}{2}$ c., because of curtailed production and short stocks. As for *potassium prussiate*, there are only two tons on the market to-day, with the price 55-65c. against 40-50c. two weeks ago. It is expected that stocks will shortly be replenished, with relief to the buyers and sellers alike.

*Copper sulphate (blue vitrol)* reflects the present higher price of copper. However, although the price for moderate quantities is \$9.15-\$9.25 and quoted at \$9 for carloads, it is possible to obtain the latter at \$8.75 per cwt.

### NAVAL STORES

Except during the Civil War, turpentine and rosins were never higher than at present. Both are selling heavily in foreign markets as well as in the domestic, with the result that spot stocks here are scarce. At this writing spirits of turpentine is quoted at \$1.27 per gal., against \$1.05 two weeks ago. During the war, Europe produced practically no naval stores, so is now buying heavily in this country. Another factor of importance in explaining high prices is the tie-up of coastwise shipping, which affects the ports of New York, Boston, Savannah, New Orleans, Galveston and Norfolk.

### VEGETABLE OILS

The speculative feature, which for many weeks has characterized the vegetable-oil market, is beginning to disappear. What little oil there is, is in the hands of manufacturers and wholesalers who, under present conditions, are in no hurry to sell. It is believed in some quarters that vegetable oils have attained the apex. No advance is expected unless a heavy buyer enters the market. This opinion is substantiated by the fact that the purchase of only 660 bbl. of soya bean oil last week sent the price up a cent.

Is the present price of linseed oil too high? Well, it was never higher—even during the stress of war. Shortage of seed is the reason given, but there are dealers who admit that inflation is a still better reason. In the first week of June raw in 5-bbl. lots sold for \$1.59 per gal.; second week, \$1.83; third week, \$1.90; first week of July, \$1.90; second week \$2.15; third week, \$2.20—an increase of 38 per cent in less than two months. It would seem that linseed oil has succumbed to the speculative fever that has been ravaging the vegetable-oil market for some time.

As a result of increased domestic consumption soya bean oil has advanced in price, which now is 18c. per lb. in tank cars, f.o.b. Pacific Coast, as compared with 16 $\frac{1}{2}$ -17 $\frac{1}{2}$ c. at the last writing. It is expected to go even higher, due to lax buying in the Orient. Domestic demand is quickening.

Castor oil should advance sharply in the near future, owing to the usual fall demand by the textile mills and tanners. No castor beans are being grown in the United States this year, necessitating entire dependence on Brazil. Brazil has already shipped large quantities of seed to France.

St. Louis, July 23, 1919.

The fertilizer manufacturers, who started the original heavy demand for 60 per cent *sulphuric acid*, have kept up their demands so insistently that the price is expected to rise within the next few weeks. One local producer put a new plant in operation the first part of the month and

already is swamped by orders. The price holds steady at \$12 a ton.

The 66 per cent *sulphuric* is normal, demands being steady but not heavy, the price remaining at \$18 a ton. The demand for *oleum* also is normal and the price remains the same.

*Muriatic acid* is in immense demand. Producers are frankly at a loss to know where the supply is going and why orders should be so heavy. One producer believes that a shortage of tank cars is being felt, which is causing buyers to place numerous orders in the hopes of getting through the amount of *muriatic* they desire. Prices hold steady at \$22 a ton for 18 per cent.

*Sodium bisulphate* (niter cake) is reported oversold. Orders are being refused by some local producers who have their supply contracted for until Jan. 1. The price is \$2.50 a ton. Steel manufacturers are still buying heavily for pickling purposes.

*Zinc chloride* is extremely active. One local producer reports sending a million pounds in July to a customer who formerly bought only 1,500,000 lb. in a year. The price is 3 $\frac{1}{2}$ c. a lb. on contract and 4c. on the open market for 50 per cent.

*Zinc oxide* continues very strong with the demand greater than the supply. Production has been increased locally, but orders are still hard to fill. The demand for low-leaded and lead free is strong, but not quite as strong for high-leaded. Prices remain the same.

*Barytes* continue in heavy demand at same prices, but an ultimate advance is declared inevitable, by local producers. Unusually heavy business by paint manufacturers is reflected strongly in the *barytes* field. Prices for water-floated *barytes* remain at \$23 to \$25 a ton, including barrels; \$21.50 to \$23.50 in bags, extra charge being made for the bags; all prices f.o.b. mills in carload lots.

Chicago, July 28, 1919.

Marked advances in a few items of heavy chemicals and circus stunts on the part of most items in the line of naval stores have made the Chicago market interesting for the past two weeks. High prices seemingly have no deterrent effect on sales, all dealers reporting business far in excess of normal.

*Heavy Chemicals*—*Caustic soda* and *soda ash* are holding firm at quotations established three weeks ago, solid *caustic* bringing 3c. to 3 $\frac{1}{2}$ c., and *granulated* 4c., *soda ash* 2c. The threatened advance in *bleaching powder* (calcium hypochlorite) has not occurred, price remaining firm at 2c. with good demand.

*Niter cake* (*sodium bisulphate*) shares in the prosperity of *sulphuric acid*, quantities having been placed under contract by the steel interests at about \$4 a ton. Spot sales in small lots are bringing a considerably higher price. *Sodium bichromate* has advanced from 7 $\frac{1}{2}$ c. on the first of the month to 11 $\frac{1}{2}$ c. today, with apparently the end not yet in sight.

*Potassium carbonate* is still being quoted by some dealers as high as 22c., though several lots have changed hands at a much lower figure; but 17c. should probably be considered actual price today. *Yellow potassium prussiate* is another article that has gone up to a surprising degree, sales being effected this week at 65c. against an easy market of 35c. three weeks ago.

*Vegetable Oils*—*Linseed oil* struck a record high figure in Chicago about ten days ago of \$2.73 in barrels, this figure holding but a short time, however. It is now quoted at \$2.48. The very complete tie-up of building operations now in effect here may cause some reduction, as local consumption will be seriously reduced. Other vegetable oils have remained steady, quotations of July 9th letter still holding good.

*Flotation Oils, Naval Stores*.—There seem to be no limits to the price heights which have been or may be reached in these lines. Turpentine heads the list with plenty of sales being effected at 1.36, and its habit of jumping not less than one cent a day seems to have become confirmed. Rosin is also high, grade WW being quoted at 21.60, F at 17.70, E at 17.45 and B at 16.50, delivered Chicago. Pine tar in barrels brings 35c. to 37c. and pine tar oil 40c.



## General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JULY 28, 1919

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.134	\$0.54 - \$0.60
Acetone.....lb.	15	
Acid, acetic, 28 per cent.....cwt.	2.75 - 3.00	3.00 - 3.25
Acetic, 56 per cent.....cwt.	5.50 - 6.00	6.00 - 6.50
Acetic, glacial, 99 1/2 per cent, carboys.....cwt.	12.00 - 12.50	13.00 - 13.50
Boric, crystals.....lb.	13 - 13 1/2	13 1/2 - 14
Boric, powder.....lb.	13 - 13 1/2	13 1/2 - 14
Hydrochloric, tech. 20 deg.....cwt.	1.00 - 1.50	1.75 - 2.50
Hydrofluoric, 52 deg.....lb.	10	11 - 16
Lactic, 44 per cent, tech.....lb.	11 - 14	12 - 16
Lactic, 22 per cent, tech.....lb.	.05 - .06	.05 - .07
Molybdic, C. P.....lb.		6.50 - 7.40
Nitric, 40 deg.....lb.	.06 - .06 1/2	.07 - .08 1/2
Nitric, 42 deg.....lb.	.07 - .07 1/2	.08 - .09
Oxalic, crystals.....lb.	.24 - .25	.25 - .30
Phosphoric, Ortho, 50 per cent, solution.....lb.	.09	.10
Picric.....lb.	.30 - .40	.50
Pyrogallol, resublimed.....lb.		2.30
Sulphuric, 60 deg., tank cars.....ton	12.00 - 14.00	
Sulphuric, 60 deg., drums.....ton	17.00	22.00
Sulphuric, 60 deg., carboys.....ton	20.00	25.00
Sulphuric, 66 deg., tank cars.....ton	16.00 - 18.00	23.00
Sulphuric, 66 deg., drums.....ton	20.00 - 21.00	25.00 - 26.00
Sulphuric, 66 deg., carboys.....ton	25.00	30.00 - 40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars.....ton	22.00	27.00
Sulphuric, fuming, 20 per cent. (oleum) drums.....ton	25.00	32.00
Sulphuric, fuming, 20 per cent. (oleum) carboys.....ton	30.00	35.00
Tannic, U. S. P.....lb.		1.30 - 1.40
Tannic (tech.).....lb.		.42 - .55
Tartaric, crystals.....lb.		.84 - .86
Tungstic, per lb. of WO.....lb.		1.20 - 1.40
Alcohol, Ethyl.....gal.	4.00	4.85
Alcohol, Methyl.....gal.	1.20	1.23
Alum, ammonia lump.....lb.	.03 1/2 - .04 1/2	.04 - .04 1/2
Alum, potash lump.....lb.	.08 - .09	.08 - .09
Alum, chrome lump.....lb.	.15 - .16	.18 - .20
Aluminum sulphate, commercial.....lb.	.01 1/2 - .02	.02 - .02 1/2
Aluminum sulphate, iron free.....lb.	.02 1/2 - .03	.03 - .03 1/2
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07	.09
Ammonia, anhydrous, cylinders (100-150 lb.).....lb.		.30 - .35
Ammonium carbonate, powder.....lb.	.13 - .14	.14 - .14 1/2
Ammonium chloride, granular (white salamoniac).....lb.	.12 1/2 - .13	.13 1/2 - .14
Ammonium chloride, granular (gray salamoniac).....lb.	.12 - .12 1/2	.13 - .13 1/2
Ammonium nitrate.....lb.	.10	.11 - .12
Ammonium sulphate.....lb.	.05	.06
Amyl acetate.....gal.		3.65
Arsenic, oxide, lumps.....lb.		.09 - .09 1/2
Arsenic, sulphide, powdered.....lb.		
Barium chloride.....ton	75.00 - 80.00	85.00
Barium dioxide (peroxide).....lb.	.22	.24
Barium nitrate.....lb.	.10 - .10 1/2	.11 - .12
Barium sulphate (precip.) (blanc fixe).....lb.	.02 1/2	.02 1/2 - .04
Bleaching powder (see calcium hypochlorite)		
Blue Vitriol (see copper sulphate)		
Borax (see sodium borate)		
Bromine (see sulphur, roll)		
Bromine.....lb.		.65 - .75
Calcium acetate.....cwt.	2.00 - 2.05	2.10
Calcium carbide.....lb.		.04 - .05
Calcium chloride, fused, lump.....ton	19.00 - 25.00	30.00 - 40.00
Calcium chloride, granulated.....lb.	.01 1/2 - .01 3/4	.02 - .02 1/2
Calcium hypochlorite (bleaching powder).....cwt.	1.75 - 1.80	2.00 - 2.50
Calcium peroxide.....lb.		1.50 - 1.70
Calcium phosphate, monobasic.....lb.		.75
Calcium sulphate, precipitated.....lb.		.09 - .09 1/2
Carbon bisulphide.....lb.	.05 1/2	.06
Carbon tetrachloride, drums.....lb.	.11	.12 - .14
Carbonyl chloride (phosgene).....lb.		.75
Caustic potash (see potassium hydroxide)		
Caustic soda (see sodium hydroxide)		
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.05	.08
Cobalt oxide.....lb.		1.60 - 1.65
Copperas (see iron sulphate)		
Copper carbonate, green precipitate.....lb.		.28 - .31
Copper cyanide.....lb.		.65 - .70
Copper sulphate, crystals.....lb.	.08 1/2 - .08 3/4	.09 - .09 1/2
Cream of tartar (see potassium bitartrate)		
Epsom salt (see magnesium sulphate)		
Formaldehyde, 40 per cent.....lb.		.20 - .21
Glauber's salt (see sodium sulphate)		
Glycerine.....lb.		.20 - .21
Iodine, resublimed.....lb.		.42 - .45
Iron oxide, red.....lb.		.06 - .08
Iron sulphate, (copperas).....cwt.	1.00	1.20 - 1.50
Lead acetate, normal.....lb.		.12 1/2 - .14
Lead arsenate (paste).....lb.		.15 - .17
Lead nitrate, crystals.....lb.		.85 - .86 1/2
Litharge.....lb.		.09 1/2 - .10 1/2
Lithium Carbonate.....lb.		1.50
Magnesium carbonate, technical.....lb.		.13 - .04 1/2
Magnesium sulphate, U. S. P.....100 lb.	2.00 - 2.63	2.75
Magnesium sulphate.....100 lb.	1.75	2.00
Nickel salt, double.....lb.	.14	.15
Nickel salt, single.....lb.	.12	.15 - .16
Phosgene (see carbonyl chloride)		
Phosphorus, yellow.....lb.		.35 - .37
Potassium bichromate.....lb.	.25 - .28	.30
Potassium bitartrate (cream of Tartar).....lb.		.55 - .60
Potassium bromide, granular.....lb.		.49 - .50
Potassium carbonate, U. S. P.....lb.	.60	.65
Potassium carbonate, crude.....lb.	.17	.20
Potassium chlorate, crystals.....lb.	.25	.27 - .30
Potassium cyanide, 98-99 per cent.....lb.	nominal	
Potassium hydroxide (caustic potash).....lb.	.32	.35 - .40
Potassium iodide.....lb.		3.30 - 3.40
Potassium nitrate.....lb.	.19	.21
Potassium permanganate.....lb.		.55 - .60
Potassium prussiate, red.....lb.		.75 - .80
Potassium prussiate, yellow.....lb.	.30 - .32	.35 - .40
Potassium sulphate.....ton	225.00	

	Carlots	Less Carlots
Rochelle salts (see sodium potas. tartrate)		
Sal ammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake.....ton	17.00 - 18.00	1.19
Silver cyanide.....oz.		1.60
Silver nitrate.....100 lb.	1.85 - 1.90	2.00
Soda ash, light.....100 lb.	2.25	2.50
Sodium acetate.....lb.	.06 - .07	.07
Sodium bicarbonate.....100 lb.	2.35	2.75 - 3.00
Sodium bichromate.....lb.	.11 - .12	.12 - .13
Sodium bisulphate (nitre cake).....ton	3.00 - 8.00	10.00
Sodium bisulphate.....cwt.	1.80 - 1.90	2.00 - 2.10
Sodium borate (borax).....lb.	.07 1/2	.08
Sodium carbonate (sal soda).....100 lb.	1.35 - 1.50	1.50 - 1.75
Sodium chlorate.....lb.	.15	.16 - .18 1/2
Sodium cyanide.....lb.	.30	.31 - .34
Sodium fluoride.....lb.	.13	.14 - .15
Sodium hydroxide (caustic soda).....100 lb.	2.75	3.50
Sodium molybdate.....lb.	2.50	3.25
Sodium nitrate.....100 lb.	3.00 - 3.25	3.75 - 4.00
Sodium nitrite.....lb.	.09 1/2 - .10	.10 - .13
Sodium peroxide, powdered.....lb.		.30 - .32
Sodium phosphate, dibasic.....lb.	.03 1/2 - .04 1/2	.04 - .05
Sodium potassium tartrate (Rochelle salts).....lb.		.43 - .45 1/2
Sodium prussiate, yellow.....lb.	.18 - .18 1/2	.19 - .20
Sodium silicate, solution (40 deg.).....lb.	.01 1/2 - .02	.02 - .02 1/2
Sodium silicate, solution (60 deg.).....lb.	.02 1/2	.04
Sodium sulphate, crystals (Glauber's salt) cwt.	1.05 - 1.35	1.50 - 2.00
Sodium sulphide, crystal, 60-62 per cent. (conc).....lb.		.05 - .06
Sodium sulphite, crystals.....lb.	.03 1/2	.04
Strontium nitrate, crystals.....lb.	.25	.28
Sulphur chloride.....lb.	.05 1/2	.06
Sulphur, crude.....ton	35.00	37.50
Sulphur dioxide, liquid, cylinders.....lb.		.10 - .12
Sulphur (sublimed), flowers.....100 lb.	3.05	3.60
Sulphur, roll (brimstone).....100 lb.	2.70	3.65
Tin bichloride (stannous).....lb.	.48	.49 - .50
Tin oxide.....lb.		.60
Zinc carbonate, precipitate.....lb.		.20
Zinc chloride, gran.....lb.	.12 1/2	.13 1/2 - .14
Zinc cyanide.....lb.	.49	.50
Zinc dust.....lb.	.09 - .11	.11 - .12
Zinc oxide, dry American.....lb.		.10 - .11
Zinc sulphate.....lb.	.03 1/2	.04

## Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude.....lb.	\$1.10	\$1.10
Alpha naphthol, refined.....lb.	1.40	1.50
Alpha naphthylamine.....lb.	.35	.50
Aniline oil, drums extra.....lb.	.25	.30
Aniline salts.....lb.	.28	.33
Anthracene, 86% in drums (100 lb.).....lb.	.90	1.00
Benzaldehyde (f.f.c.).....lb.	1.00	1.15
Benidine, base.....lb.	.95	1.15
Benidine, sulphate.....lb.	.90	1.10
Benzoic acid, U. S. P.....lb.	1.00	1.10
Benzoate of soda, U. S. P.....lb.	.95	1.10
Benzol, pure, water-white, in drums (100 lb.).....gal.	.24	.28
Benzol, 90% in drums (100 lb.).....gal.	.23 1/2	.27
Benzyl chloride, 95-97% refined.....lb.	.35	.40
Benzyl chloride, tech.....lb.	.35	.35
Beta naphthol benzoate.....lb.	3.75	4.50
Beta naphthol, sublimed.....lb.	.75	.80
Beta naphthol, tech.....lb.	.45	.55
Beta naphthylamine, sublimed.....lb.	2.25	2.35
Cresol, U. S. P., in drums (100 lb.).....lb.	.18	
Ortho-cresol, in drums (100 lb.).....lb.	.23	.25
Cresylic acid, 97-98%, straw color, in drums.....gal.	.85	.90
Cresylic acid, 95-97%, dark, in drums.....gal.	.80	.85
Cresylic acid, 56%, first quality, drums.....gal.	.60	
Dichlorobenzol.....lb.	.07	.10
Diethylaniline.....lb.	1.50	2.25
Dimethylaniline.....lb.	.50	.57
Dinitrobenzol.....lb.	.25	.37
Dinitrochlorbenzol.....lb.	.25	.28
Dinitronaphthalene.....lb.	.45	.55
Dinitrophenol.....lb.	.30	.32
Dinitrotoluol.....lb.	.38	.45
Dip oil, 25% tar acids, car lots, in drums.....gal.	.38	.46
Diphenylamine.....lb.	.70	.75
H-acid.....lb.	1.75	2.25
Metaphenylenediamine.....lb.	1.20	1.80
Monochlorobenzol.....lb.	.10	.14
Monoethylaniline.....lb.	1.50	1.75
Naphthalene crushed, in bbls. (250 lb.).....lb.	.06	.08
Naphthalene, flake.....lb.	.06 1/2	.07 1/2
Naphthalene, balls.....lb.	.08 1/2	.10
Naphthionic acid, crude.....lb.	.75	1.25
Nitrobenzol.....lb.	.13	.15
Nitro-naphthalene.....lb.	.35	.45
Nitro-toluol.....lb.	.17	.20
Ortho-amidophenol.....lb.	4.25	
Ortho-dichlor-benzol.....lb.	.15	.20
Ortho-nitro-phenol.....lb.	.90	1.00
Ortho-toluidine.....lb.	.30	.45
Ortho-nitro-toluol.....lb.	.27	.40
Para-amidophenol, base.....lb.	2.60	3.50
Para-amidophenol, HCl.....lb.	2.75	3.25
Para-dichlor-benzol.....lb.	.06	.10
Paranitraniline.....lb.	1.00	1.25
Para-nitro-toluol.....lb.	1.35	1.50
Paraphenylenediamine.....lb.	2.75	4.00
Paratoluidine.....lb.	1.50	1.75
Phthalic anhydride.....lb.	1.75	2.15
Phenol, U. S. P., drums (dest.), (240 lb.).....lb.	.10	.13
Pyridin.....gal.	2.50	
Resorcin, technical.....lb.	3.50	3.75
Resorcin, pure.....lb.	6.50	7.75
Salicylic acid, tech., in bbls. (110 lb.).....lb.	.25	.30
Salicylic acid, U. S. P.....lb.	.30	.35
Salol.....lb.	.75	.80
Solvent naphtha, water white, in drums, 100 gal. gal.	.20	.27
Solvent naphtha, crude, heavy, in drums, 100 gal. gal.	.18	.24
Sulphanilic acid, crude.....lb.	.25	.30

Tolidine.....	lb.	1.75	—	2.50
Toluidine, mixed.....	lb.	.45	—	.80
Toluol, in tank cars.....	gal.	.22	—	.24
Toluol, in drums.....	gal.	.23	—	.30
Xylidine, drums, 100 gal.....	lb.	.44	—	.46
Xylol, pure, in drums.....	gal.	.37	—	.45
Xylol, pure, in tank cars.....	gal.	.35	—	—
Xylol, commercial, in drums, 100 gal.....	gal.	.23	—	.27
Xylol, commercial, in tank cars.....	gal.	.22	—	—

### Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow.....	lb.	\$0.44	—	\$0.45
Beeswax, refined, yellow.....	lb.	.48	—	.55
Beeswax, white pure.....	lb.	.65	—	.68
Carnauba, No. 1.....	lb.	.90	—	1.00
Carnauba, No. 2, regular.....	lb.	.75	—	.85
Carnauba, No. 3, North Country.....	lb.	.60	—	.65
Japan.....	lb.	.18	—	.21
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.06	—	—
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	.06	—	.06
Paraffine waxes, refined, 118-120 m.p.....	lb.	.07	—	.08
Paraffine waxes, refined, 128-130 m.p.....	lb.	.09	—	.10
Paraffine waxes, refined, 133-135 m.p.....	lb.	.11	—	.12
Paraffine waxes, refined, 135-137 m.p.....	lb.	.12	—	—
Stearic acid, single pressed.....	lb.	.25	—	.27
Stearic acid, double pressed.....	lb.	.28	—	.29
Stearic acid, triple pressed.....	lb.	.30	—	.32

### Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr. 0.930-0.940.....	gal.	\$0.78	—	—
Pine oil, pure, dest. dist.....	gal.	.68	—	—
Pine tar oil, ref., sp. gr. 1.025-1.035.....	gal.	.45	—	—
Pine tar oil, ref., sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.33	—	—
Pine tar oil, double ref., sp. gr. 0.965-0.990.....	gal.	.65	—	—
Pine tar, ref., thin, sp. gr. 1.080-1.090.....	gal.	.34	—	—
Turpentine, crude, sp. gr. 0.900-0.970.....	gal.	.72	—	—
Hardwood oil, f.o.b. Mich., sp. gr. 0.960-0.990.....	gal.	.27	—	—
Pine wood creosote, ref.....	gal.	.48	—	—

### Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.....	280 lb.	\$16.75	—	\$17.25
Rosin E-I.....	280 lb.	17.50	—	18.75
Rosin K-N.....	280 lb.	21.00	—	22.25
Rosin W. G.-W. W.....	280 lb.	22.50	—	22.75
Wood rosin, bbl.....	280 lb.	17.25	—	—
Spirits of turpentine.....	gal.	1.25	—	1.27
Wood turpentine, steam dist.....	gal.	1.19	—	—
Wood turpentine, dest. dist.....	gal.	1.10	—	—
Pine tar pitch, bbl.....	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.).....	bbl.	12.75	—	13.50
Retort tar, bbl.....	280 lb.	13.75	—	14.50
Rosin oil, first run.....	gal.	.81	—	.91
Rosin oil, second run.....	gal.	.83	—	.93
Rosin oil, third run.....	gal.	.85	—	1.07
Rosin oil, fourth run.....	gal.	.88	—	1.10

### Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.33	—	—
70-72 deg., steel bbls. (85 lb.).....	gal.	.31	—	—
68-70 deg., steel bbls. (85 lb.).....	gal.	.30	—	—
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal.	.23	—	—

### Crude Rubber

Para-Upriver fine.....	lb.	\$0.54	—	\$0.55
Upriver coarse.....	lb.	.31	—	.33
Upriver cauchoo ball.....	lb.	.31	—	.34
Plantation—First latex crepe.....	lb.	.39	—	.40
Rubbed smoked sheets.....	lb.	.38	—	.39
Brown crepe, thin, clean.....	lb.	.34	—	.35
Amber crepe No. 1.....	lb.	.36	—	.37

### Oils

#### VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls.....	lb.	\$0.19	—	\$0.21
Castor oil, AA, in bbls.....	lb.	.21	—	.23
China wood oil, in bbls.....	lb.	.22	—	.24
Cocoonut oil, Ceylon grade, in bbls.....	lb.	.19	—	.20
Cocoonut oil, Cochín grade, in bbls.....	lb.	.21	—	.22
Corn oil, crude, in bbls.....	lb.	.22	—	.24
Cottonseed oil, crude (f.o.b. mill).....	lb.	.22	—	.23
Cottonseed oil, summer yellow.....	lb.	.27	—	.30
Cottonseed oil, winter yellow.....	lb.	.28	—	.29
Linseed oil, raw, car lots.....	gal.	2.22	—	—
Linseed oil, raw, tank cars.....	gal.	2.15	—	2.17
Linseed oil, boiled, car lots.....	gal.	2.17	—	2.22
Olive oil, commercial.....	gal.	2.30	—	2.50
Palm, Lagos.....	lb.	.17	—	.18
Palm, bright red.....	lb.	.17	—	.18
Palm, Niger.....	lb.	.16	—	.17
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.26	—	.27
Peanut oil, refined, in bbls.....	lb.	.29	—	.30
Rapeseed oil, refined in bbls.....	gal.	1.55	—	1.60
Rapeseed oil, blown, in bbls.....	gal.	1.60	—	1.70
Soya bean oil (Manchurian), in bbls., N. Y.....	lb.	.20	—	—
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.18	—	.18

#### FISH

Winter pressed Menhaden.....	gal.	\$1.25	—	\$1.35
Yellow bleached Menhaden.....	gal.	1.27	—	1.37
White bleached Menhaden.....	gal.	1.29	—	1.38
Blown Menhaden.....	gal.	1.35	—	1.40

### Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated.....	ton	\$25.00	—	\$36.00
Barytes, off color.....	ton	20.00	—	25.00
Blanc fixe, dry.....	lb.	.03	—	.04
Blanc fixe, pulp.....	ton	30.00	—	40.00
Casein.....	lb.	.16	—	.18
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.04	—	.06

Chalk, English, dense.....	lb.	.04	—	.05
China clay (Kaolin), imported, lump.....	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump.....	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered.....	ton	25.00	—	40.00
Feldspar.....	ton	11.00	—	15.00
Fluorspar, acid grade, lump, f.o.b. mines.....	net ton	\$30.00	—	\$35.00
Fluorspar, acid grade, ground, f.o.b. mines.....	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered.....	ton	30.00	—	40.00
Fuller's earth, imported, powdered.....	ton	—	—	—
Pumice stone, imported.....	lb.	.03	—	.06
Pumice stone, domestic.....	lb.	.02	—	—
Shellac, TN.....	lb.	—	—	—
Shellac, D. C.....	lb.	—	—	—
Shellac, V. S. O.....	lb.	—	—	—
Shellac, Diamond L.....	lb.	—	—	—
Shellac, orange, fine.....	lb.	—	—	—
Shellac, orange, superfine.....	lb.	1.10	—	1.15
Shellac, A.C. garnet.....	lb.	.95	—	—
Shellac, bleached, bone dry.....	lb.	1.35	—	—
Shellac, bleached, fresh ground.....	lb.	1.05	—	—
Soapstone.....	ton	15.00	—	25.00
Talc, domestic.....	ton	16.00	—	60.00
Talc, imported.....	ton	55.00	—	60.00

### Refractories

Following prices are f.o.b. works:

Chrome brick.....	net ton	90-100 at Chester, Penn.
Chrome cement.....	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay.....	net ton	35-45 at Clearfield, Penn.
Clay brick, 2nd quality.....	net ton	30-35 at Clearfield, Penn.
Magnesite, dead burned.....	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4 1/2 x 2 1/2 in.....	net ton	80-90 at Chester, Penn.
Silica brick.....	net ton	41-45 at Mt. Union, Penn.

### Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$220.00	—	—
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon.....	lb.	.32	—	\$0.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon.....	lb.	.70	—	—
Ferro-manganese, 70-80% Mn.....	gross ton	100.00	—	125.00
Spiegelisen, 16-20% Mn.....	gross ton	30.00	—	50.00
Ferro-molybdenum, per lb. of Mo.....	lb.	1.85	—	2.00
Ferro-silicon, 50%.....	gross ton	85.00	—	115.00
Ferro-silicon, 75%.....	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%.....	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.....	lb.	1.40	—	1.60
Ferro-uranium, 35-50%, of U.....	lb.	7.00	—	—
Ferro-vanadium, 30-40% per lb. of contained V.....	lb.	5.50	—	7.00

Resales and overstocks make above prices approximate.

### Ores and Semi-finished Products

Chrome ore, 35-40%, Cr <sub>2</sub> O <sub>3</sub> .....	unit	\$0.60	—	—
Chrome ore, 48% and over.....	unit	.80	—	—
Coke, foundry, f.o.b. mines.....	net ton	5.25	—	\$5.50
Coke, furnace, f.o.b. mines.....	net ton	4.50	—	5.00
Petroleum coke, f.o.b. Atlantic seaboard.....	net ton	16.00	—	16.50
Fluorspar, gravel, f.o.b. mines.....	net ton	20.00	—	25.00
Manganese ore, 45% Mn and over.....	unit	.60	—	.65
Manganese ore, chemical (MnO <sub>2</sub> ).....	gross ton	60.00	—	70.00
Molybdenite, 85% MoS <sub>2</sub> , per lb. of MoS <sub>2</sub> .....	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO <sub>3</sub> and over per unit of WO <sub>3</sub> .....	unit	9.00	—	12.00
Tungsten, Wolframite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub> .....	unit	7.00	—	10.00
Uranium oxide, 96%.....	lb.	—	—	—
Vanadium pentoxide, 99%.....	lb.	6.00	—	—
Pyrites, foreign, lump.....	unit	.15	—	—
Pyrites, foreign, fine.....	unit	.15	—	—
Pyrites, domestic, fine.....	unit	.14	—	—
Ilmenite, 50% TiO <sub>2</sub> .....	net ton	30.00	—	—
Rutile, 95% TiO <sub>2</sub> .....	net ton	200.00	—	—
Carnotite, minimum 2% U <sub>3</sub> O <sub>8</sub> , per lb. of U <sub>3</sub> O <sub>8</sub> .....	lb.	2.75	—	3.00

Resales and overstocks make above prices approximate.

### Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

#### BUILDING MATERIALS

Portland cement, at dock, without bags.....	bbl.	\$2.30	—	—
Lump lime, common, including container.....	300 bbl.	2.65	—	—
Common brick, at dock.....	M.	15.00	—	—
Hollow building tile.....	M.	194.40	—	—
At factory, Perth Amboy, N. J. } 8x12x12.....	M.	291.60	—	—
Yellow pine, 3x4 to 8x8, 20-24 ft. long.....	M.	40.00	—	—
Yellow pine, 3x4 to 8x8, 20-24 ft. long at Chicago.....	M.	39.50	—	—
Yellow pine, 3x4 to 8x8, 20-24 ft. long at St. Louis.....	M.	37.00	—	—
Roofings, tar pitch (14 lb. per 100 sq. ft.).....	ton	60.00	—	—
Roofings, tar pitch (in 400-lb. bbl.).....	ton	21.00	—	—
Roofings, asphalt pitch.....	ton	34.00	—	—
Roofings, asphalt felt.....	ton	65.00	—	—
Roofings, slate-surfaced, per roll of 108 sq. ft.....	—	2.00	—	—
Roofings, slate-finished shingles, 100 sq. ft.....	—	5.00	—	—
Linseed oil, raw in barrels.....	gal.	2.15	—	—
Linseed oil, 5 gal. cans.....	gal.	2.28	—	—
Red lead, dry, 100 lb. keg.....	lb.	.13	—	—
Red lead, in oil, 100 lb. keg.....	lb.	.14	—	—
Red lead, dry, 5 lb. cans.....	lb.	.15	—	—
Red lead, in oil, 5 lb. cans.....	lb.	.16	—	—
White lead, dry and in oil, 100 lb. keg.....	lb.	.13	—	—
White lead, dry and in oil, 25 and 50 lb. kegs.....	lb.	.13	—	—
White lead, dry and in oil, 5 lb. cans.....	lb.	.15	—	—

#### STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.....	100 lb.	\$2.45	—	—
Angles, 3 to 6-in., 1-in. thick.....	100 lb.	2.45	—	—
Tees, 3-in. and larger.....	100 lb.	2.45	—	—
Plates.....	100 lb.	2.66	—	—
Rivets, structural, 1-in. and larger.....	100 lb.	4.20	—	—
Rivets, conehead for boilers, 1-in. and larger.....	100 lb.	4.30	—	—
Sheets, No. 28 black.....	100 lb.	4.35	—	—
Sheets, No. 10 blue annealed.....	100 lb.	3.55	—	—
Sheets, No. 28 galvanized.....	100 lb.	5.70	—	—

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.



# INDUSTRIAL

## Financial, Construction and Manufacturers' News

### Construction and Operation

#### Alabama

**MONTGOMERY**—The Alabama-Georgia Syrup Co., Jones St., plans to build a 2-story, 95 x 170-ft. factory on North Court St. Estimated cost, \$50,000. Okel & Cooper, Vandiver Bldg., architects.

#### Arizona

**JOHNSON**—The Keystone Copper Co., Newton, Kan., will erect a 100-ton mill, using the flotation and concentration process, at its copper mines six miles east of Johnson.

#### California

**ELRIDGE**—The State of California is having plans prepared by the State Department of Engineering, Sacramento, for rebuilding the sewage disposal plant at Sonoma State Hospital, to include an Imhoff tank and sprinkling filter. Estimated cost, \$20,000.

**NORTH BERKELEY** (Berkeley P. O.)—The East Bay Water Co., Oakland, plans to build a filtration plant. C. H. Wilhelm, Oakland, engineer. Hazen, Whipple & Fuller, 50 East 42nd St., New York City, N. Y., architects.

**SACRAMENTO**—The city voted \$1,800,000 bonds for the construction of a filtration plant and water system. Noted May 1.

**WATERMAN**—The State of California is having plans prepared by the State Engineering Department, Sacramento, for the construction of a new sewage disposal system at the Preston School of Industry, to include an Imhoff tank and sprinkling system. Estimated cost, \$14,000.

**YOUNTVILLE**—The State of California is having plans prepared by the State Engineering Department, Sacramento, for the construction of a sewage disposal plant at the Veterans' Home, to include an Imhoff tank and sprinkling filter. Estimated cost, \$10,000.

#### Colorado

**GATEWAY**—The Carolite Mining Co. plans to build a reduction plant here. Estimated cost, \$25,000.

#### Connecticut

**JEWETT CITY**—The Ashland Cotton Co. plans to build a 1-story, 150 x 190-ft. mill. Work will be done by day labor. Estimated cost, \$65,000.

**NEW HAVEN**—The State Board of Health, Capitol, Hartford, will erect a laboratory on Huntington St. Estimated cost, \$100,000.

#### Florida

**MIAMI**—The city plans to build a filtration plant. State Board of Health, Jacksonville, preparing plans.

**TAMPA**—The city plans to build a filtration plant. State Board of Health, Jacksonville, preparing plans.

#### Illinois

**CHICAGO**—The Century Rubber Works, 1346 Rawson St., plans to build a 3-story, 200 x 350-ft. factory on La Salle St. Estimated cost, \$200,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, Ohio, engineer.

**FREEDPORT**—The Furst-McNess Co. has awarded the contract for the construction of a 5-story, 75 x 160-ft. reinforced-concrete chemical factory, to H. W. Hoist & Co., State Bank Bldg., Rock Island. Estimated cost, \$125,000.

#### Kansas

**RUSSELL**—The city plans to build a complete sewerage system and disposal plant. Estimated cost, \$60,000. Black & Veatch, International Bldg., Kansas City, Mo., engineers.

#### Maryland

**HIGHLANDTOWN** (Baltimore P. O.)—The Jones & Lamb Co., Pennsylvania and Fulton Aves., Baltimore, has awarded the contract for remodeling the plant of the Monumental Brewery Co., at 7th and Lombard Sts. into a meat packing plant and oil refinery, to the Consolidated Engineering Co., 243 Calvert Bldg., Baltimore. Estimated cost, \$500,000.

#### Michigan

**DETROIT**—The C. B. Bohn Foundry Co., Hart Ave., has awarded the contract for the construction of a 1-story, steel, brick and concrete addition to its core room and a 30 x 30 ft. brick and reinforced-concrete gas house with settling tanks, gas and air line tunnels and ducts, to C. H. Reisdorf, 753 Greenwood Ave.

**DETROIT**—The Fisher Body Corp., Piquette Ave., will soon award the contract for the construction of a 6-story, 156 x 581-ft. paint shop on St. Antoine St. and Piquette Ave. Smith, Hinchman & Grylls, 710 Washington Arcade, engineers.

#### Massachusetts

**MITTINEAGUE**—The Strathmore Paper Co. plans to build a factory here. Estimated cost, \$100,000.

**WORCESTER**—The Sewer Commission plans to install an Imhoff sewerage purification system. Estimated cost, \$250,000. Address M. Gault, commissioner.

#### Minnesota

**MINNEAPOLIS**—The Northwestern Distilled Water Co., 627 Bassett Pl., will soon award the contract for the construction of a 1-story, 30 x 50-ft. distilled water factory at North Minneapolis. Estimated cost, \$5000.

**ST. PAUL**—Charles Weinhausen & Co., 480 Jackson St., plans to construct a 4-story, 110 x 230-ft. reinforced-concrete paper factory and office building on 14th St., near Pine St. Estimated cost, \$200,000.

#### Missouri

**MACON**—The city has awarded the contract for the construction of a sewage disposal plant, to W. McClurken, 3897 Westminster St., St. Louis. Estimated cost, \$16,000.

**ST. LOUIS**—The T. J. Sayman Co., 2117 Franklin Ave., has awarded the contract for the construction of a 1-story, 50 x 154-ft. soap factory at 2131 Franklin Ave., to the Sayman Real Estate & Investing Co., 2117 Franklin Ave. Estimated cost, \$10,000.

#### Nebraska

**LINCOLN**—The Lincoln Paint & Color Co. plans to construct a 2-story, 40 x 130-ft. factory at 811 M St. Fliske & McGinnis, 533 Bankers' Life Bldg., architects. Estimated cost, \$250,000.

#### New Jersey

**IRVINGTON** (Newark P. O.)—The Jennings Silver Co., 309 Nye Ave., has awarded the contract for the construction of a 2-story, 40 x 90-ft. factory, to the Standard Building Block Co., 21st St. Estimated cost, \$10,000.

**JAMESBURG**—The Department of Architecture, 142 West State St., Trenton, received lowest bid for the construction of a sewerage system at the State Home for Boys, from G. L. Robinson, 39 East 28th St., New York City, N. Y. Plans include a 54-ft. stone filter bed, sludge bed, etc. Estimated cost, \$10,000. Noted July 1.

**NEWARK**—The Patton Paint Co., Chester Ave., has awarded the contract for the construction of a 2-story, 61 x 121-ft. factory, to C. R. Heddon Co., Prudential Bldg., at \$63,465. Noted June 15.

**SALEM**—The city will soon award the contract for the construction of a filtration plant, including a coagulating basin, chemical house, filter house and all appliances. W. H. Boardman, 426 Walnut St., Philadelphia, engineer.

**TRENTON**—The Thermoid Rubber Co., Whitehead Rd., plans to build a 3-story, 100 x 270-ft. plant, here. Estimated cost, \$150,000. Osborn Engineering Co., 848 Prospect Ave., Cleveland, Ohio, engineer.

#### New York

**COHOES**—James E. Gledhill, 541 West 34th St., New York City, has awarded the contract for the construction of a 2-story, 100 x 400-ft. brick and steel wall paper mill, to C. P. Boland Construction Co., 30 4th St., Troy. Estimated cost, \$250,000.

**KINGS PARK**—The State Hospital Commission, Capitol, Albany, will soon award the contract for extending the sewage disposal plant at the State Hospital, here. Estimated cost, \$11,800.

**LITTLE FALLS**—The Barnet Leather Co., 598 East Mill St., plans to build a 3-story addition to its plant. Estimated cost, \$35,000. E. L. White, superintendent.

**NIAGARA FALLS**—The Niagara Falls Gas & Electric Light Co., 306 Niagara Works, Riverway, will soon award the contract for the construction of a new gas plant at Buffalo Ave. and 22nd St. Estimated cost, \$200,000. A. H. Merritt, superintendent.

**NUNDA**—Peck & Pratt, Inc., have purchased a site and will erect a condensed milk plant. Laboratory equipment will be installed in same. Estimated cost, between \$35,000 and \$50,000.

**TROY**—The Rensselaer Polytechnic Institute plans to build a 2-story addition to the William Weightman Walker laboratory. Estimated cost, \$175,000. Address Palmer C. Ricketts, president.

#### North Dakota

**NEW ROCKFORD**—The city plans to install a water softening plant. Estimated cost, \$20,000.

#### Ohio

**ASHLAND**—The Ashland Tire & Rubber Co. plans to build a 2-story, 75 x 125-ft. rubber plant. Estimated cost, \$90,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, engineer.

**ASHLAND**—The Faultless Rubber Co. plans to build a 3-story, 80 x 160-ft. factory addition here. Estimated cost, \$75,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, engineer.

**BARNESVILLE**—Morris Knowles, engineer, Jones Law Bldg., Pittsburgh, has submitted a report to the borough for the construction of a sewerage system and a disposal plant. Estimated cost, \$100,000. People now running campaign to raise the necessary funds.

**CLEVELAND**—The Atlantic Foundry Co., 7510 Morgan Rd., plans to build a 1-story, 26 x 36-ft. foundry addition. Estimated cost, \$5000.

**CLEVELAND**—The Crescent Brass Manufacturing Co., 8410 Lake Ave., plans to rebuild the 3-story, 80 x 120-ft. factory which was recently destroyed by fire. Estimated cost, \$50,000.

**COLUMBUS**—The Columbus Tire & Rubber Co., Hayden Bldg., has awarded the contract for the construction of a 2-story, 75 x 300-ft. rubber factory on the west bank of the Olentangy River, to Cummins & Blair Co., Cleveland. Noted June 15.

**CLEVELAND**—The McElrath Tire & Rubber Co., 620 Union Bldg., plans to construct a 2-story, 60 x 200-ft. factory on East 131st St. Estimated cost, \$80,000.

**CLEVELAND**—Benjamin Moore & Co., 1514 Marquette Ave., plans to build a 4-story, 60 x 100-ft. paint factory on East 71st and Grant Ave. Estimated cost, \$60,000.

**CLEVELAND**—The National Malleable Castings Co., 7706 Platt Ave., plans to build a 3-story, 49 x 62-ft. research laboratory at 10509 Quincey Ave. Estimated cost, \$50,000.

**MARION**—The American Malleable Castings Co. plans to build a 1-story, 60 x 70 and 70 x 75-ft. addition to its foundry here. Estimated cost, \$50,000. Osborn Engineering Co., 2848 Prospect Ave., Cleveland, engineer.

**MIDDLETOWN**—The American Rolling Mills Co. will build an entire new sheet mill and equip same at cost of \$3,500,000. Work will be done by day labor.

**WARREN**—The D. & M. Cord Tire Co., Engineers Bldg., Cleveland, plans to construct a 3-story, 80 x 120-ft. rubber plant. Estimated cost, \$75,000.

### Oklahoma

**IDABEL**—The city will receive bids until Aug. 4 for the construction of a complete sewerage system, including main and lateral sewers and a sewage disposal plant. Johnson & Benham, Firestone Bldg., Kansas City, Mo., engineers. Noted Feb. 1.

### Oregon

**PORTLAND**—The Portland Gas & Coke Co., 294 Yamhill St., plans to build a 1-story, 68 x 70-ft. and 32 x 94-ft. factory, on Linnton Rd. Estimated cost, \$10,000.

### Pennsylvania

**LANCASTER**—The city has retained Gannett, Seelye & Fleming, engineers, 204 Locust St., Harrisburg, to prepare plans and supervise construction of a sewage disposal plant.

### Rhode Island

**CUMBERLAND** (Manville P. O.)—The city plans to construct a new sewerage system. Estimated cost, \$150,000. O. Perry Sarle, 146 Westminster St., Providence, engineer.

### South Carolina

**BARNWELL**—The city plans an election to vote on \$50,000 bonds for the construction of a sewerage system, including a septic tank. Tomlinson Engineering Co., 1003 Loan & Exchange Bank Bldg., Columbia, engineer.

**LAKE CITY**—The city will receive bids about Aug. 20 for the construction of a sewerage system, gravity type septic tank disposal. Estimated cost, \$60,000. Tomlinson Engineering Co., 1003 Loan & Exchange Bank Bldg., Columbia, engineer.

### Utah

**LEHI**—The Utah County School Board will receive bids until Aug. 15 for the construction of a 2-story, 137 x 160-ft. high school. A chemical laboratory will be installed. Estimated cost, \$100,000. Ware & Treganza, Utah Savings & Trust Bldg., Salt Lake City, engineer.

### West Virginia

**HUNTINGTON**—The Standard Ultramarine Co., 5th Ave. and 25th St., plans to build a 3-story, 80 x 100-ft. laboratory for the manufacture of bluing, on 24th St. Estimated cost, \$25,000.

### Wisconsin

**PESHTIGO**—The Peshtigo Pulp & Paper Co. plans to build a 2-story, 70 x 178-ft. pulp and paper factory on Main St. Estimated cost, \$55,000. J. A. Kittle, president. L. A. DeGuerre, Grand Rapids, engineer.

**TWO RIVERS**—Juul & Smith, Imig Bldg., Sheboygan, is preparing plans for a 2-story, 60 x 190-ft. brick and concrete aluminum factory on Main St. Estimated cost, \$30,000. Owner's name withheld.

### Ontario

**BURLINGTON**—The city will soon award the contract for the construction of a sanitary sewerage system. Estimated cost, \$150,000. Chipman & Power, Mail Bldg., Toronto, engineers.

**DUNDAS**—A. W. Dreaske, chairman of the Sewer Committee, received bids for the construction of sewage disposal works, including sprinkler system, etc., from Curran & Clomont, Dundas, \$152,032; Canadian Engineering & Construction Co., Toronto, \$216,583; Connolly-Agnew Co., Toronto, \$228,222. Noted June 15.

**FORD CITY**—The Imperial Oil Co., 156 Church St., Toronto, has awarded the contract for the construction of a refinery to the Wescott Contracting Co., Windsor. Estimated cost, \$100,000.

**TORONTO**—The city plans to build a pumping station and filtration plant at Victoria Park. Estimated cost, \$2,000,000. R. C. Harris, City Hall, engineer.

**TORONTO**—The city plans to build an experimental activated sludge unit. Estimated cost, \$50,000. R. C. Harris, City Hall, engineer.

**TORONTO**—The Northern Aluminum Co., 158 Sterling Rd., will soon award the contract for the construction of a 10-story, 60 x 280-ft. reinforced concrete factory for the manufacture of aluminum ware and wire. Estimated cost, \$300,000. C. P. Turner, 1005 Lindsay Bldg., Winnipeg, Manitoba, engineer.

### Quebec

**RED MILL**—The Canada Paint Co., 572 William St., Montreal, will receive bids in August for the construction of a 3-story, 40 x 60-ft. factory to replace the one which was recently destroyed by fire. Estimated cost, \$42,000.

## Coming Meetings and Events

THE AMERICAN CERAMIC SOCIETY will hold a meeting in Chicago, Sept. 24.

THE AMERICAN CHEMICAL SOCIETY will hold its Fall meeting in Philadelphia, Pa., Sept. 2-6 inclusive.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its Fall meeting in Chicago, Sept. 23-25 inclusive.

THE AMERICAN FOUNDRYMAN'S ASSOCIATION will hold its 1919 convention in Philadelphia, Sept. 29 to Oct. 4.

THE AMERICAN GAS ASSOCIATION will hold its annual convention and exhibition of gas appliances and apparatus at the Hotel Pennsylvania, New York, October 13 to 18.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its Fall meeting in Chicago, Ill., Sept. 22-27.

THE AMERICAN STEEL TREATERS' SOCIETY will hold its first annual convention in Chicago, Ill., Sept. 22-27.

THE FIFTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in Chicago, Ill., Sept. 22-27 inclusive.

THE INSTITUTE OF METALS DIVISION of the A. I. M. E. will hold its next meeting in Philadelphia, Pa., Sept. 29 to Oct. 4.

THE INSTITUTE OF METALS will hold its Autumn meeting in Sheffield, England, Sept. 24-25.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its Fall meeting in Chicago from Sept. 24 to 27.

## Industrial Notes

MESSRS. T. L. WHEELER AND J. C. WOODRUFF, both of whom held the rank of Major in the Chemical Warfare Service, have associated themselves together for the organization of a general consulting business and chemical engineering research work, investigation of processes, design and managing of chemical plants and the organization of technical staffs for chemical concerns. Special attention will be given to the treatment of animal and vegetable fats and oils, electroplating and the electrolytic refining of metals, corrosion and activation of charcoal. Offices have been established at 280 Madison Ave., New York City.

Lieut.-Commander John L. Murrie, formerly of the New York Edison Co. and Capt. Edward F. McCrossin, formerly of the McCrossin Engineering Co. have been relieved of active duty in the navy and army respectively and have organized the firm of MURRIE & CO. with offices at 74 Broadway, New York. Murrie & Co. will conduct a general consulting business and will give special attention to financial reports on gas and coal by-product plants.

THE UNITED FILTER CORP. has established a sales office at 35 Montgomery St., San Francisco, under the direction of the Western Sales & Engineering Corporation. In addition to this office the company's business on the West coast is also taken care of by Kennard & Pierce of Los Angeles, and the United Iron Works, Spokane, Wash. These offices, together with the older ones in Salt Lake City, Chicago and New York, will provide a complete service in this country.

THE NEW JERSEY CONCENTRATING CO., 66 York St., Jersey City, N. J., has established a plant for the electromagnetic concentration of low-grade tungsten ores. Impurities such as tin and copper are removed almost completely with an excellent recovery of the tungsten. The plant includes equipment for crushing, sampling and magnetic separation. A sworn sampler and weigher of Messrs. Ledoux & Co. is always on the premises. Proximity to the waterfront and railroad yards gives excellent facilities for loading and unloading ore. Storage space is provided for customers' use.

THE ELECTRIC FURNACE CO., Alliance, Ohio, announces that it has installed a battery of two Baily electric furnaces at the Capital Brass Works, Detroit, Michigan. These furnaces are of the standard 105-kw. tilting type, with hearth capacities

of 1500 lb. each. They will be used for melting yellow brass scrap and borings, in the foundry. The Buick Motor Co., Flint, Mich., has purchased its second Baily furnace for melting phosphor bronze. The furnace is of the tilting type, rated at 1500-lb. hearth capacity and an electrical capacity of 105 kw. It is also announced that the Akron Bronze & Aluminum Co., Akron, Ohio, has installed a 50-kw. rectangular tilting type Baily electric furnace in its jobbing foundry. This furnace has a hearth capacity of 300 to 500 lb. and will be used for a wide variety of compositions. Heats will range from 100 to 500 lb. and will include gun metal, phosphor bronze, red and yellow brass.

THE BLAW-KNOX CO., Pittsburgh, announces the appointment of Mr. Frank O. Leitzell as engineer-salesman in the sheet and tin mill specialties department. Mr. Leitzell was formerly assistant to the general manager of the H. K. Porter Co., Pittsburgh. This company recently completed and formally presented to the children of its employees a playground at Hoboken. This recreation center is complete in every detail and is intended for the employees themselves as well as their children.

## Stocks and Bonds

Closing Bid and Asked Quotations July 30, on N. Y. Stock Exchange

### CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am. Ag. Ch....	106	106½	Mat. Al. Wk....	31	36
do. pf. ....	100		Ten. C. & C. 15½	15½	
Barrett Co. 134½	134½		Un. Dyewood 63	70	
do. pf. ....	78½	81	do. pf. ....	97	97½
G. n. Chem. 175	190		Va.-Car. Ch. 84½	87	
do. pf. ....	103	108	do. pf. ....	113½	113½
Int. Ag. Ch. 31½	33½				
do. pf. ....	85	88			

### Bonds

Am. Ag. Ch., 1st cv. 5s, '28	97½	100
Am. Ag. Ch., cv. db. 5s, '24	106½	109
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32	84½	85½
Va.-Car. Ch., 1 mtg. 5s, '23	95½	96
Va.-Car. Ch., cv. db. 6s, '24	103½	104

### PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co. 93	93½		P-A Pet & Tr 113	113½	
Cal. Pet. ....	47½	47½	do. pf. ....	195	197½
do. pf. ....	80½	81	Pierce Oil ....	23½	23½
Col. G. & E. 62½	62½		Royal Dutch. 94	94½	
Mex. Pet. ....	188	189	Sinclair O&R. 59½	59½	
do. pf. ....	109	111	Texas Co. 265	267	
Ohio Cit. Gas. 56½	57		Tex. Pac. Ltd.		
do. pf. ....	54½		Tr. ....	400	500
Ohio Fuel S. 52	54½		Tidewater Oil 240	245	
Okla. P. & R. 11	11½				

### Bonds

Columbia Gas & Electric, 1 5s, '27	90	90½
Col. G. & E., std. 1 5s, '27	90	90½
Pan-Am. Pet. & Tr. 1 6s, '19-27	130	
Pierce Oil, cv. db. 6s, '24	105	106
Pierce Oil, cv. 5% Notes, '20	109	129
Sin. O. & R. 1 ln. 7s, '20, with atk. war.	142	
Sin. O. & R. 1 ln. 7s, '20 without atk. war.	99½	100
Texas Co., db. 6s, '31	103	103½
Union Oil of Cal. 1 5s, '31	94½	95
United Fuel Gas 1 mtg. 6s, ser. A, '36	94½	95½

### IRON AND STEEL SECURITIES

	Bid	Ask		Bid	As
Am. St. F. ....	44½	45	Pitts. Ste. pf. 95	97	
Beth. Steel. ....	96	97	Rep. Iron & Steel. ....	95½	95½
do. class B. 97½	98		do. pf. ....	104½	105½
do. pf. 8% 114½	114½		Sloss Sheff. I. ....	69	70
do. pf. 7% 102	109		do. pf. ....	92	95
Central Fdry. 39½	41		Superior Steel 44	45	
do. pf. ....	71	73	do. I pf. ....	105	110
Col. F. & I. 50½	51		Trans. & W. ....	66	68
do. pf. ....	137	137½	Steel. ....	56½	56½
Cruc. Steel. ....	100½	101½	Un. Alloy St. 56½	56½	
Great No. Ore 47½	47½		U.S.C.I.P. & F. 32½	32½	
Gulf Sta. Steel 66	67½		do. pf. ....	69	70
do. I pf. ....	94	97	U. S. Steel. ....	110½	111½
Lack. Steel. ....	86½	87	do. pf. ....	116½	117
Mid.St.&Ord. 56½	56½		Va. Coal, I&C 65	67	
Nova Scotia Steel. ....	82	83			

### Bonds

Beth. Steel, 1 ext. gtd. S.F. 5s, '26	96½	97
Beth. Steel, 1 ln. ref. 5s, Ser. A, '42	89	90½
Beth. Steel, P. M. & I. S. F. 5s, '36	86	86
Buff & Susq. Iron, 1 S. F. 5s, '32	92	100
Buff & Susq. Iron, deb. 5s, '27		
Cent. Found., 1 mtg. S. F. 6s, '21	87	
Col. F. & I., gn. S. F. 5s, '43	90½	92
Ill. Steel, db. 4½s, '40	84½	86
Ind. Steel, 1 mtg. gtd. 5s, '52	96	97
Lack. Steel, 1 5s, '23	97	98
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50	97	98
Mid. St. & Ord., elt. cv. S. F., '36	89½	89½
Nat. Tube, 1 mtg. gtd. 5s, '52	95	98
Rep. I. & S. F. mtg., 5s, '40	92½	93½
Tenn. C. & I. R.R., gn. 5s, '51	90	90
U. S. Steel, S. F. 5s, '63	100½	101
Va. C., I. & C., 1 5s, '49	85½	85½